JUN 25 1932

MAINTENANCE ENGINEERING

In Plants, Mills, and Factories

JULY 1932

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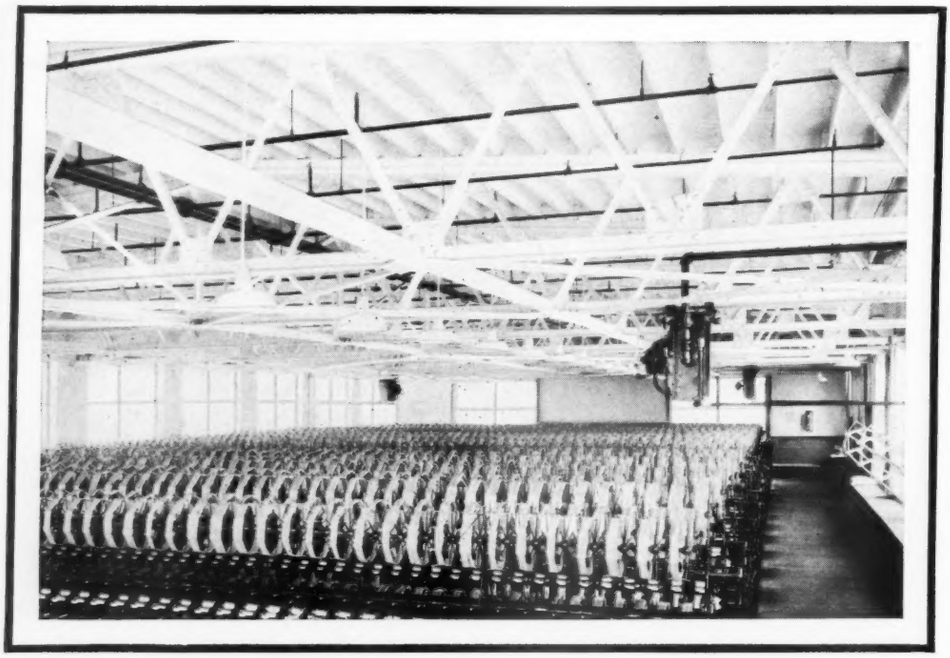

says E. D. TILLSON
Illuminating Engineer, Commonwealth Edison Co., Chicago

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MAINTENANCE ENGINEERING

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1932

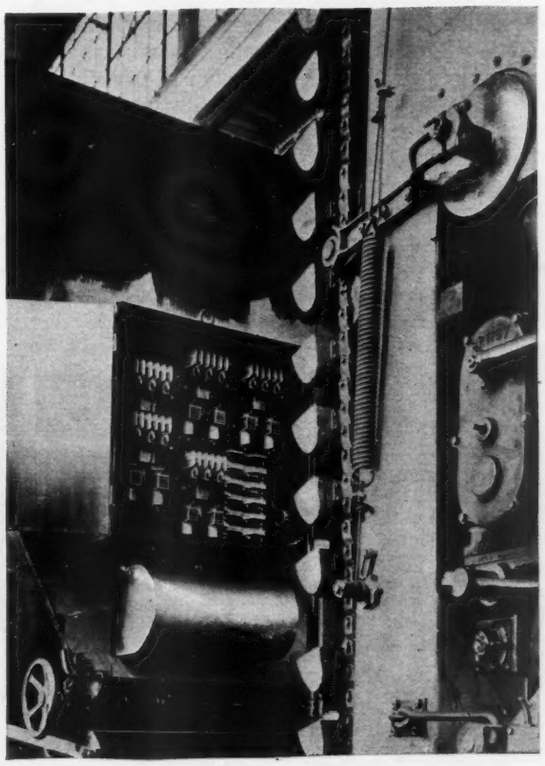
What Automatic Motor Control Means to the Maintenance Engineer

F. L. SPANGLER

Industrial Engineer
Allen-Bradley Company
Milwaukee, Wis.

A SINGLE, large motor running a lineshaft from which machines on one or more floors of the factory were operated was once the most common type of drive. Such a motor was started and stopped twice a day, and the factory superintendent usually assumed the very important responsibility of starting the lineshaft motor. Although the advantages of group drive in its proper place are unchallenged the necessity of providing an individual motor for certain types of machines is now recognized. Many modern plants use hundreds of individually motorized machines. Each machine motor must be started and stopped by the operator; furthermore, it is often necessary to start and stop individual motors much more frequently than in the case of lineshaft drives. With this responsibility put into the hands of general shop labor, it is desirable to eliminate the human element from motor starting.

Some motorized machines are stopped whenever they run out of work temporarily, which may happen a dozen times a day. Other motorized machines start and stop several thousand times a day as part of the normal duty cycle. Introduction of individual motor drives has brought a rapid development of automatic devices, such as machine feeders and tool control, which make further demands upon automatic motor control.



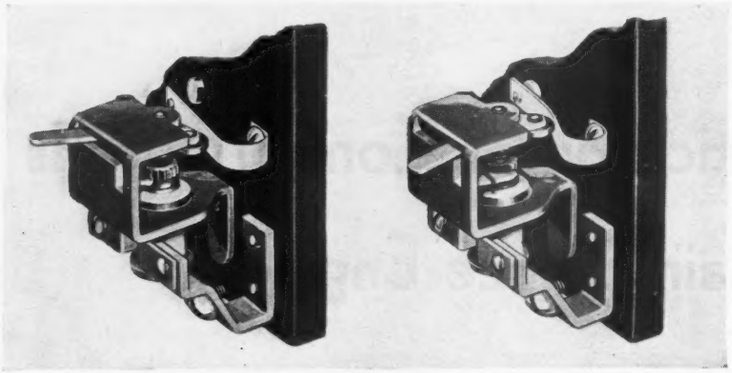
Four motors operating a sand slinger in a foundry are controlled by these switches. Magnetic relays protect the motors against overloads.

With the development of automatic motor control came the natural evolution of remote pilot control, using automatic pressure switches, float switches, limit switches, and the like. Each machine today is studied on the basis of its own requirements. The type of automatic motor control best suited for a given purpose can be determined by the maintenance engineer only if he has an intelligent understanding of motor characteristics and knows how such factors as torque, speed, acceleration, duty cycle, and other elements influence his choice.

Because the squirrel-cage induction motor is so important in modern industrial plants, the discussion in this article is limited to squirrel-cage motor controls. Furthermore, since maintenance engineers are generally familiar with manual or hand-operated starters, only automatic

starters will be given consideration.

The squirrel-cage induction motor has no commutator, no brushes, and no insulated rotor winding. It is possible to start such a motor from standstill with an across-the-line switch. The automatic or magnetically operated across-the-line starting switch has, therefore, become widely used. When the switch is closed full line voltage is impressed upon the stator winding, a momentary inrush of starting current occurs, and the motor accelerates to full speed. The contacts are opened and closed by magnets that are controlled through push-buttons, snap switches, float switches, pressure switches, thermostats, or other contact-making devices.



In the resistance type of thermal overload relay shown here melting of the solder by which a ratchet wheel is attached to a shaft allows the wheel to turn and open the contacts. The view at the left shows the relay with contact open, on the right with contact closed.

Any dirt or rust on the pole face or on the hinged armature of the switch will produce an undesirably large air gap, resulting in an increase in the alternating current that energizes the operating coil. It is important that pole faces and armatures "seal" when closed.

The contacts which make and break the motor current must stand more abuse than any other part of the switch. Pitting, roughening, and fusing are almost entirely eliminated by the use of rolling contacts made of hard copper. When the switch is closed the contacts first come together at a point high up on their curved surfaces and then roll down on each other, so that the final, or running, contact is made on the lower part of the contact surfaces. When the switch opens the contacts roll upward and break the current on the upper part of the contact surfaces. The great break-away strength resulting from this rolling action reduces the possibility of welding. Also, because of a slight dragging action inherent in the rolling construction, the contact surfaces are wiped clean and bright.

In switches of small capacity, not provided with rolling contacts, welding or corrosion is often prevented by the use of silver-to-silver contacts. If current-carrying parts are silver plated, clean, non-corrosive surfaces are insured where lugs, shunts, and the like are bolted together. Maintenance of these parts is thereby considerably reduced and frequent cleaning is unnecessary.

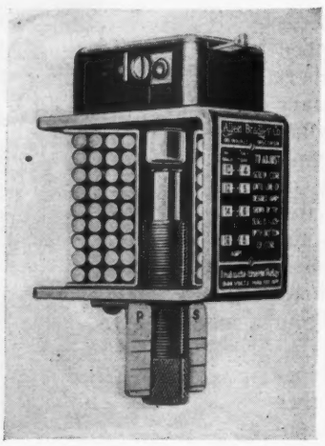
Since automatic across-the-line switches are required to handle the starting current of induction motors and must break the motor circuit even under stalled-rotor conditions, special provision must be made to extinguish arcing at the contacts and to prevent flashovers between adjacent line contactors. In the smaller sizes of switches arc hoods of special design extinguish or snuff out any arc that may occur when the switch is opened. Barriers between the line contactors effectively prevent flashovers. In the larger sizes, magnetic blowout coils assure the disruption of severe arcs under extreme conditions of overload.

Arc hoods, arc barriers, and magnetic blowout coils make possible compact switches of high rating, thus reducing the cost of automatic control equipment. Maintenance engineers should realize that the arc-barrier and magnetic-blowout units are important points of inspection and maintenance. Strange as it may seem, such arc hoods are often thoughtlessly removed by operators, or are sometimes not replaced by careless inspectors or maintenance men. In fact, it has been found necessary in some control equipment to interlock the arc hood electrically with the magnetic operating coil so that the switch is inoperative unless the arc hood is in proper position.

Another important unit of the automatic across-the-line switch is the overload relay. It protects the motor against injury from continuous overloads and has reduced production delays. A further advantage is that the machine operator cannot tamper so easily with the overload setting of a relay as he can with fuses. Once an overload relay has been set to trip at a given current value, it will function at that point almost indefinitely.

Overload relays such as are used on automatic control can roughly be classed into three divisions: (1) thermal overload relays; (2) magnetic overload relays; (3) combination thermal and magnetic overload relays. Each type of relay has its individual characteristics, and the choice of the proper one is determined by the characteristics of the driven machine and the motor to be protected.

For its operation the thermal type of overload relay depends ultimately upon the heating effect of the overload current. The magnetic relay, on the other hand, is operated by the magnetizing effect of a coil through which the motor current flows. The thermal relay may be of either the resistance or induction types, or a combination of both.



Induction-type thermal overload relay with part of magnetizing coil cut away to show the core and copper heater element.

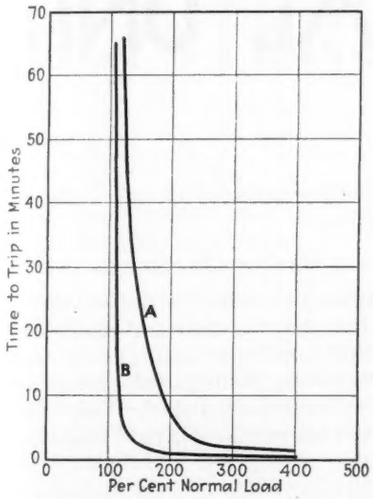
The resistance thermal overload relay is a very simple and compact device. One relay of this type has a pawl held against the contact spring by a ratchet wheel which is soldered onto a shaft extending downward into a heater element. The heater element, which is a resistance - wire coil carries the motor current.

An overload current causes the heater element to overheat the shaft sufficiently to melt the solder, thereby releasing the ratchet wheel and allowing it to turn so that the spring-actuated contacts can open. The amount of current required to melt the solder depends upon the size of the heater element.

Many standard elements are available, each having its own current rating. Should it be desirable to change the rating of the relay, it is necessary to replace the existing element with one corresponding to the new rating. The relay is so designed that replacement of the heater element is a simple job, although it is not often that a change of elements is required. The individual elements are inexpensive.

The induction thermal overload relay depends upon a current magnetically induced in the relay heater element by the motor current to supply the heat that melts the solder and opens the relay contacts. This relay acts on the transformer principle; hence it is applicable only to alternating-current motors.

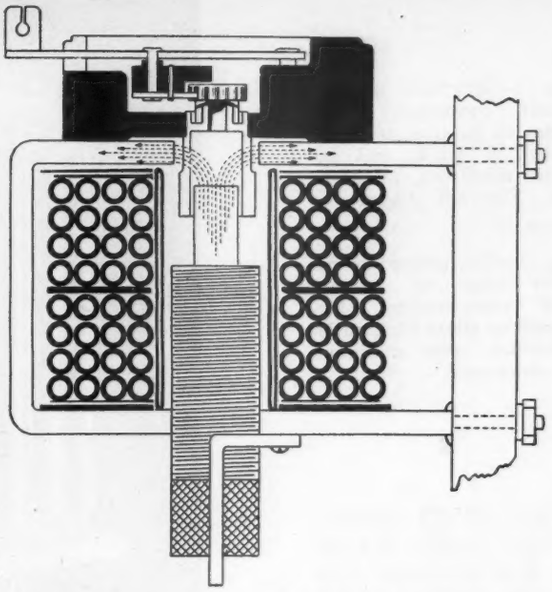
A common type of this relay em-



Typical tripping curves of induction thermal overload relay. "A" is the motor heating curve. "B" is the relay tripping time.

ploys a magnetic coil which induces a current in a hollow, copper heater tube to which is soldered a ratchet wheel that holds the contacts closed against a spring. An overload induces in the heater tube a heavy current which melts the solder, thereby releasing the ratchet wheel and tripping the relay. This relay has the advantage over the resistance relay of being adjustable over a wide range of current-tripping values.

The setting is determined by the adjustment of a threaded iron core within the relay coil. Screwing this core in or out varies the air gap and magnetic flux through the heater tube, which changes the values of the induced current and its heating effect. The current setting of the relay is read on a graduated scale. A new thermal element is not required whenever a change in overload rating is desired.



Sectional view of induction thermal overload relay showing path of magnetic flux, with details of the core, heater tube, and ratchet wheel.

This type of relay has a high reserve thermal capacity and cannot be damaged by heavy overload currents, because a heavy, copper magnetizing coil is used in place of resistor-type heater element.

Thermal overload relays are ideal in many cases for motor protection, because the purpose of such protection is to prevent the motor windings from overheating. Factors that affect the heating of motor windings also have a direct bearing on the temperature of the relay. Variations in room temperature, for example, need not be compensated for in some cases when thermal relays are used, since the effect of high room temperatures in hastening the heating of motor windings at the same time reduces the time of melting of the solder in the thermal relay.

The thermal overload relay is generally satisfactory for standard squirrel-cage motors whose stalled-rotor current is at least five times normal full-load current. These relays are not suitable for use with standard repulsion-induction, slipring, or other motors whose primary current, with stalled rotor, may be only about three times normal full-load current. The time lag inherent in the operation of the thermal relay prevents it from tripping in time to give protection against the stalled-rotor condition with such low current values.

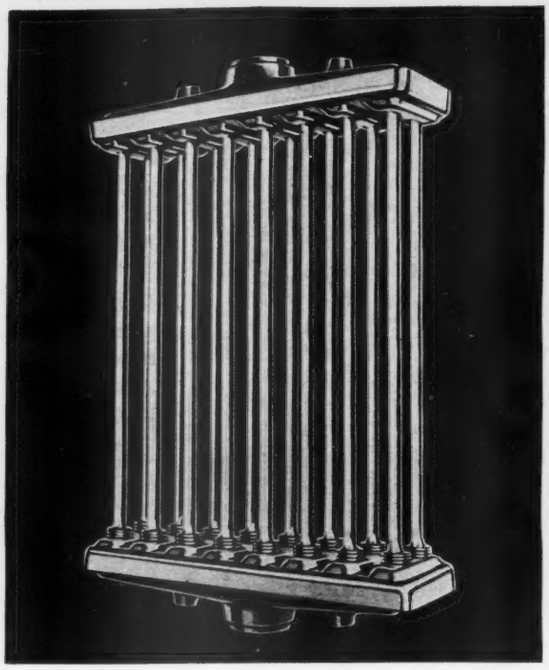
A relay of the magnetic or combined thermal-magnetic type should be used with repulsion-induction, slipring, and self-starting synchronous motors, since these relays operate sufficiently rapidly to disconnect the motor before the stalled-rotor condition results in damage.

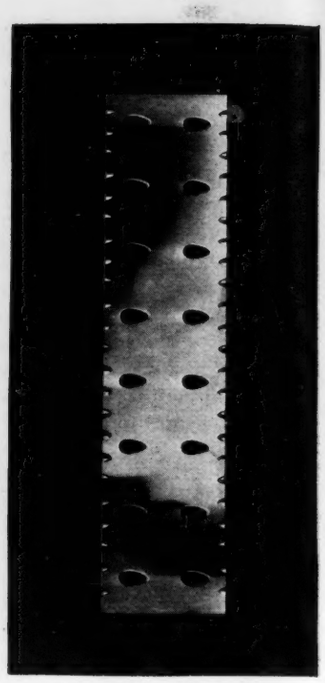
The tripping time of a magnetic overload relay equipped with a dashpot varies between certain minimum and maximum limits, the time being maximum with small overloads and minimum with large currents. Hence, this relay is spoken of as giving inverse-time-limit protection. The value of tripping current may be varied in several ways.

In one type of relay it is accomplished by adjusting the core of the relay up or down. The magnetic coil is in series with the motor and exerts an upward pull on the core, to the bottom of which is attached a piston working in the dashpot. If the dashpot is filled with oil the piston is pulled upward through the oil when an overload occurs. As soon as the piston breaks the oil seal the core snaps upward and opens the relay contacts. This action in turn causes a magnetic switch to open and disconnect the motor from the line. The core and piston then return to their former position, ready to act when the next overload occurs.

The cumulative heating effect of a series of small overloads occurring at frequent intervals in rapid succession will cause the tripping of a thermal relay before the motor is damaged, but the magnetic relay may afford no protection in such a case.

In the next article of this series the characteristics of the thermal-magnetic relay will be discussed.





Courtesy of Herman Nelson Corporation

Fig. 1—Example of unit heater composed of a series of parallel tubes attached to intake and exhaust manifolds, or headers. Fins not shown.

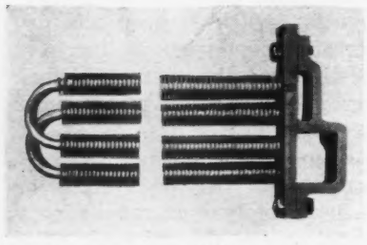
Fig. 2—Fin, pierced to receive tubes of "stream line" cross-section. Designed to allow high outlet velocities, with minimum of turbulence.

■

INDUSTRIAL UNIT

ISOLATED diffusing unit heaters for industrial plants now are very common. Essentially they are steam or water pipe, gas or electric heating elements through which a large quantity of air is forced in a desired direction by means of a fan or centrifugal blower. In point of first cost, efficiency, temperature control, and maintenance they usually are to be preferred over direct radiation or fan blast duct systems.

Air in large rooms has a tendency to stratify; and as the lighter, warmer air seeks the ceiling level, a definite temperature gradient will be set up unless some circulating device is employed. An ideal heating system would heat only the working zone of a factory, and allow portions above it to remain unheated. Unit heaters, blasting air down into this zone from above, or circulating air at the working level, more nearly approach this condition than any other system. In addition they offer ease of control, because their effect is noticeable as soon as the heat is turned on and the fans started.



Courtesy of Grinnell Company

Fig. 4—Both intake and exhaust manifolds on the same side of the heater. The tubes are long U shapes, the bends of which compensate for expansion and contraction strains.

It will be convenient here to separate steam unit heaters into two major classifications—suspended and recirculating floor box. The former, small rectangular units strategically located at numerous points in a large plant, blow air downward through diffusing louvres by means of low-power fans placed either in front of or behind the heating elements. They may range in size from about 1 ft. square, 8 in. deep, to about 3 ft. square, 1 ft. deep.

Recirculating floor box • heaters, larger units employing centrifugal blower fans, are useful in high, expansive factory rooms where heated air must be circulated over great distances, and high velocities are required. One or two of these large heaters provide a simpler layout than can be obtained with more numerous suspended units, and provide even heat distribution. Where the plant is very large and high they may be the only satisfactory solution to the heating problem. In such cases they are sometimes supplemented by a few suspended units which take care of roof losses.

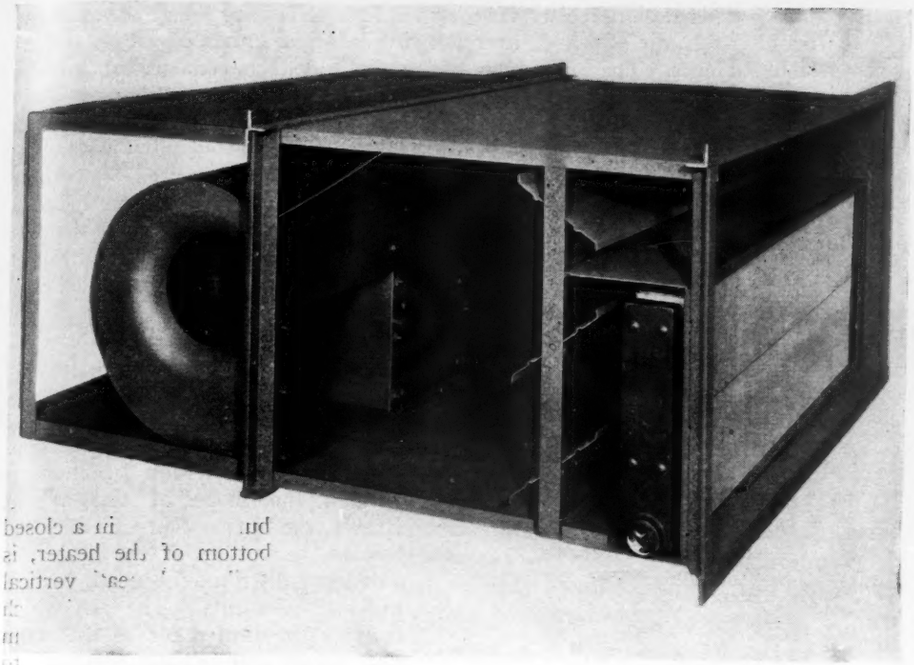
Heating Elements

Heating elements for the two classifications may be discussed under one heading, since size usually is the only characteristic distinguishing elements in the suspended and the floor type heaters offered by a single manufacturer.

Steam coils—In modern design cast-iron and steel pipe coils have given way to lighter-weight copper coils whose radiating surface is in most cases greatly increased by means of flat or helical fins. The fins usually are attached to the pipe core by brazing, welding, soldering, pressure, or by a combination of some of these.

With cast-iron heaters it is hard to prevent overheating because of the latent heat in the mass. The lighter copper heaters have overcome this difficulty, and now light-weight copper fin heaters are available for rated pressures from 2 to 250 pounds.

Those elements are in general most satisfactory which are built without



Courtesy of Buckeye Blower Company

Fig. 3—Floor-type unit, in which are used long, flat tubes of copper piercing a large series of flat fins, to which they are metallically bonded.

HEATERS

CARL HEYEL
Assistant Editor

rigid connections, such as return bends, nipples or elbows. Unequal expansion and contraction of rigid connections cause leaks and shorten the life of a heater. Most manufacturers therefore have developed units consisting of a series of parallel corrosion-resisting finned tubes attached to cast-iron or steel intake and exhaust manifolds, or headers.

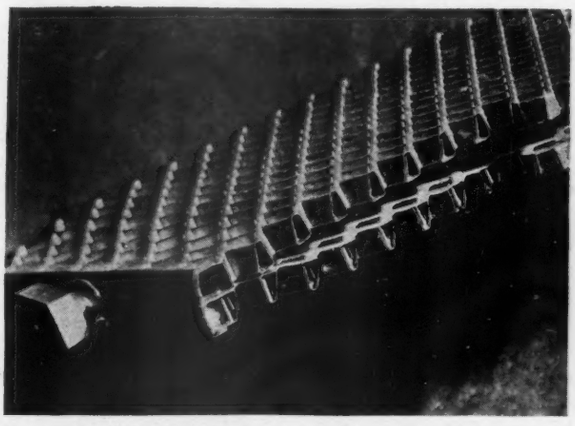
This construction (shown without the fins in Fig. 1) has the added advantage of being easy to repair. A tube may be removed and renewed without disturbing all of the others, and a single faulty pipe does not mean that a whole new section is required.

Sometimes the tubes are made with a special "stream line" cross-section, as illustrated by the piercings in the fin shown in Fig. 2, resembling the shape of airplane supports and struts. This construction aids in allowing high outlet velocities, with a minimum of turbulence, to be obtained from the heaters. For this same reason heater fins usually are made flat. It should be remembered, however, that in heaters especially designed for low velocity output a certain amount of turbulence inside the heater is desirable to produce the maximum amount of heat transfer from tubes to air.

Unit heater heating elements are subject to severe expansion and contraction and under certain conditions it is extremely difficult to keep the condensed steam from freezing. To meet these requirements heating elements have been designed in which the radiator is divided into two sections, the bottom section being used to temper the incoming air sufficiently to prevent freezing of the upper section when automatic valve is closed.

Several methods are in use to take care of the differences in lengths of the tubes, caused by unequal expansion, which may set up serious strains in the headers. In some cases flexible header plates are used. In the heater illustrated by Fig. 1 a bellows arrangement is incorporated in the lower end of the individual tubes. Each bellows is formed from the metal in the tube, so that there are no joints.

In the heating elements for the floor-type unit, shown in Fig. 3, long flat tubes of copper are used piercing a large series of flat fins, to which they are metallically bonded. Such bonding provides more efficient conduction of heat from the tubes than would be obtained if the fins were forced on by pressure. The flat-tube construction reduces the possibility of broken tubes due to freezing, since the expansion of freezing condensate



Courtesy of Multicell Radiator Corporation

Fig. 5—Honeycomb type of element. The criss-cross construction of flat tubing allows expansion and contraction.

rarely is sufficient to extend them beyond their elastic limit.

Another method of caring for expansion is illustrated in Fig. 4. The intake and exhaust manifolds both are on the same side of the heater, and the tubes are long U shapes whose bends compensate for expansion and contraction strains.

Courtesy of Bayley Blower Company

Figs. 6 and 7—Heater with single header, divided longitudinally into steam and return chambers. One end of tubes attached to header, other end free to permit expansion.

Accordion-like action takes care of expansion in the honey-comb type heating element illustrated in Fig. 5. In this design the heating surface consists of one-piece flat tubing whose criss-cross construction allows it to absorb expansion and contraction within itself. The large exposed tube area precludes the necessity of extended fin surfaces.

A somewhat unusual heating element is illustrated in Figs. 6 and 7. The single header is divided longitudinally into steam and return chambers. Iron circulating tubes, which are inside the radiating tubes, are connected to the steam chamber, and the radiating tubes to the return chamber. Both radiating and circulating tubes are attached to one end only, and the opposite end is free to expand without restriction. Damage to a radiating pipe may be remedied by removing the tube and plugging the opening, and the heater may be continued in service until the damaged tube is repaired or a new one obtained. This design resists freezing when sub-zero air is passed over the heater surfaces. The inner tube, not in contact with the cold air, remains filled with steam and is a source of heat that keeps the contents of the outer tube above the freezing point until all the condensate has been drained after the steam has been shut off.

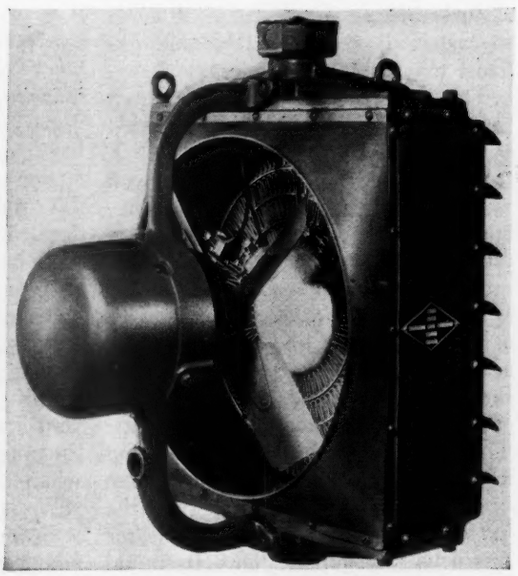
Although unit heaters coils are usually tested at the factory for high pressures, 500, and sometimes 1,000 lb. per sq.in., it is not general practice to employ high pressures in service unless process steam makes such an installation convenient. In general, the higher pressures, although they do mean increased heating value, are not recommended because they often mean added steam trap and piping trouble.

Pressures of 5 lb. per sq.in. may be termed common practice.

Electric unit heaters—Electric unit heaters are finding application in industrial heating where steam is unavailable or uneconomical, or where their added convenience of installation and operation is desired. The heating elements are spirals or strips of high-resistance alloy wire, so-called "resistance wire," sometimes imbedded in a refractory material. Casing, louvres, and fan give them an appearance similar to steam heaters. Fig. 8 shows a typical suspended electric unit.

Gas unit heaters. Gas heaters differ so widely from the other types, not only in their heating elements and general construction, but in their control, that a discussion of them is without the scope of this article. Briefly, the burner flame, in a closed box at the bottom of the heater, is uniformly distributed beneath vertical radiating elements. The fan which delivers the heated air to the room also forces air under pressure to the burner to promote combustion. Fumes are collected in a vent housing at the top of the heater and carried off through a vent pipe.

Influencing the output of unit heaters are such factors as velocity of air flow through the element whose air resistance increases almost directly with the number of sections, type of fan used, temperature of entering air, and other items which will be referred to when we consider the rating of unit heaters.



Courtesy of Ilg Electric Ventilating Company

Fig. 8—Typical suspended electric unit.

INDIVIDUAL AND GROUP DRIVES

Investment and Operating Cost Data

ROBERT DRAKE
Electrical and Mechanical Engineer, Chicago, Ill.

LAYOUT of motor drives for an industrial plant of considerable size involves a variety of problems that can be realized only by one who has attempted it. In order to limit the following discussion to reasonable length it is necessary to introduce some simplifying assumptions.

When discussing the advantages of individually driving or group driving a plant the statement should be understood to mean that the great majority of the machines are to be driven in one way or the other.

In the following discussion of comparative cost figures it should be considered that an individually driven plant is really a group of departments in a plant, which can best be individually driven, whereas a group-driven plant is a group of departments in the same or another plant which can best be group driven.

There are three principal variables that influence the economic comparison between individual and group drive.

1. Load variation on the individual machines. How high are the peak loads compared with the average load for all the plant working hours a year? A machine may operate steadily all the year around with a fairly uniform load while under cut, but if it has a great deal of idle time, set-up time, loading and unloading time it may constitute a load that is no more desirable from a power standpoint than a machine having a fluctuating load, such as a metal planer or a big drop hammer.

2. How many hours a year would it take the plant in question working at capacity, to produce its yearly output? A three-shift plant working full force all the year around, and a single-shift plant working full force only during a short "busy season" give a quite different comparison as to the total annual costs of individual versus group drive power layout.

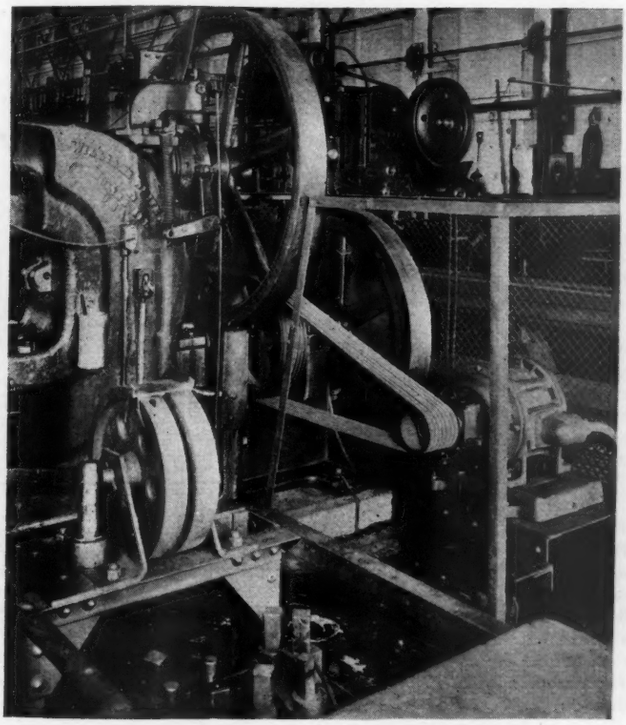
3. The average amount of power re-

FUNDAMENTAL reasons for such differences as there may be in first cost and operating costs of group drive and individual drive are:

1. The higher first cost, maintenance cost, and repair cost per horsepower as well as the poorer electrical performance and lower reliability of motors, starters, and like equipment in small sizes as compared with the larger sizes.

2. In the case of both individual-drive and group-drive plants the total connected motor load exceeds the maximum demand. In group drives with skilful engineering this excess is ordinarily 10 to 25 per cent under fairly favorable conditions. With individual drives the excess is, under equally skilful engineering, 200* to 250 per cent in plants where most machines work continuously at a single job, and up to 350 or 400 per cent in plants where the work approaches jobbing in variety. For reasons explained in the text this excess is ordinarily somewhat greater in plants where the individual machines have small average power requirements than in cases where several horsepower per machine are needed.

Reasons for the second of these two items are fundamental in all cost comparisons and are discussed in this article.



The heavy flywheel on this power press helps to smooth out the peak loads on the motor, which drives it through a multiple V-belt.

*Motors have been and are being marketed with nominal ratings based on a variety of operating temperatures, which is in effect the same as varying or eliminating the permissible overload capacity. The figures given above for normal excess capacity are based on 40-deg. C. motor ratings. To apply them to 55-deg. C. motors divide the nominal nameplate rating by 1.2 to obtain the equivalent 40-deg. C. rating—the load that the motor will carry with 40-deg. C. temperature rise.

quired per machine. Other things being equal group drive shows a greater saving, as compared with individual drive, the smaller the average power requirements of the individual machines. This applies both to first cost and annual costs.

The load variation on the individual machines is the most important. It has a profound effect upon the comparative first cost and the annual cost. If each individually driven machine must be motored for six times its average load, comparisons are far less favorable to individual drive than if three or two and one-half times the average load will suffice. The comparative costs are much the same whether such excess motor capacity is necessary to avoid stalling on short peaks or overheating on long peaks, or whether it is needed to play safe, in ignorance of the real power consumption of the individual machines. If large excess capacity must go in, it requires a heavy investment in power factor correction equipment, in mains and feeder cables, in motors and starters, and leads to low efficiency of motors and mechanical transmission.

Many of us have speculated on what the performance of individual drives would be if each machine could be motored with exactly the correct size of motor. Such speculation is of little practical importance.

Any individually driven machine must, of course, be motored with regard to the maximum duty that is ever required of it. If this is a momentary peak load only the stalling torque of the motor need be considered. This is about 100 per cent overload, ordinarily, in plants where the electrical distribution system is adequate and the motors are never called upon to operate below rated voltage. If loads of more than momentary duration must be considered such great overloads cannot be assumed, particularly with 55-deg. C. enclosed motors. The line-starting motors produced by most manufacturers stall at somewhat lower loads than do the compensator-starting motors.

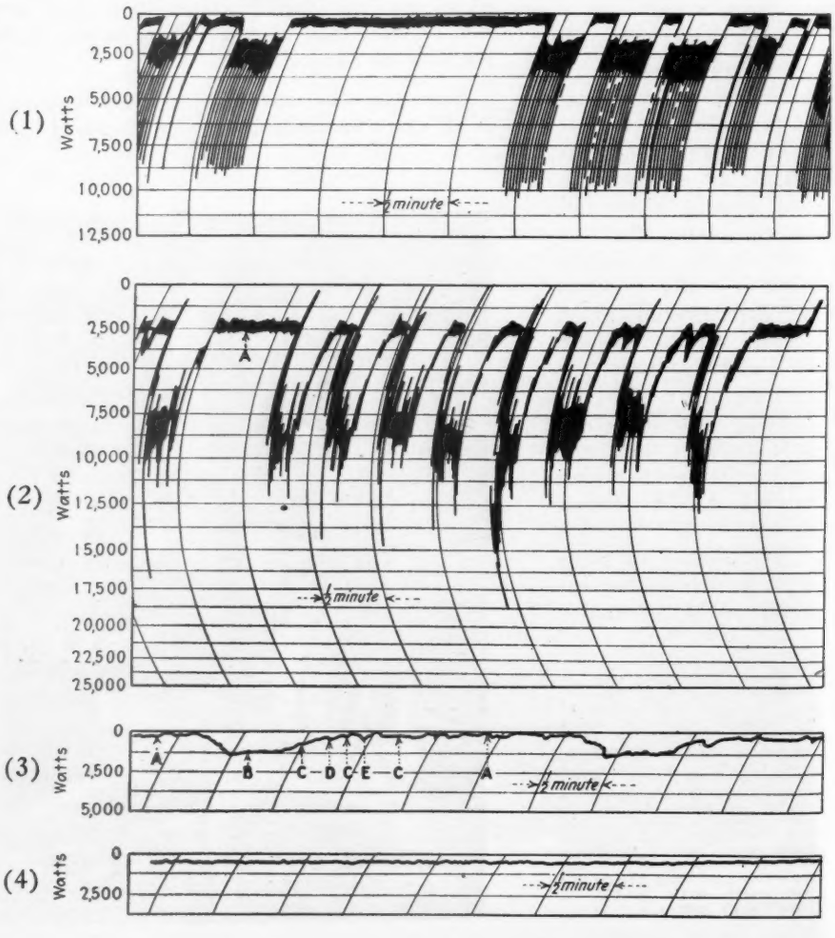
It would seem than a plant or department equipped largely with special-purpose machine tools and making a single product should be able to average close to half-load on its individual-drive motors. To one inexperienced in such matters it would seem easy to do better. Even under the most favorable conditions such loading is possible on only a part of the machines. The difficulties are various, but the majority of them may be grouped in classes.

Very few types of machines take anything approaching a uniform load. A nut tapper, which appears to run along so uniformly, shows on a graphic meter a peak on a portion of the taper part of the tap where the removal of metal is heavy, and runs almost idle during the sizing and feeding portions of the cycle. Just as we conclude that in spite of this fact the next size smaller will do, a foreman tells us that although this machine runs almost steadily on $\frac{3}{8}$-in. nuts he occasionally operates it for a month on $\frac{1}{2}$-in. nuts when a $\frac{1}{2}$-in. machine is down for repairs.

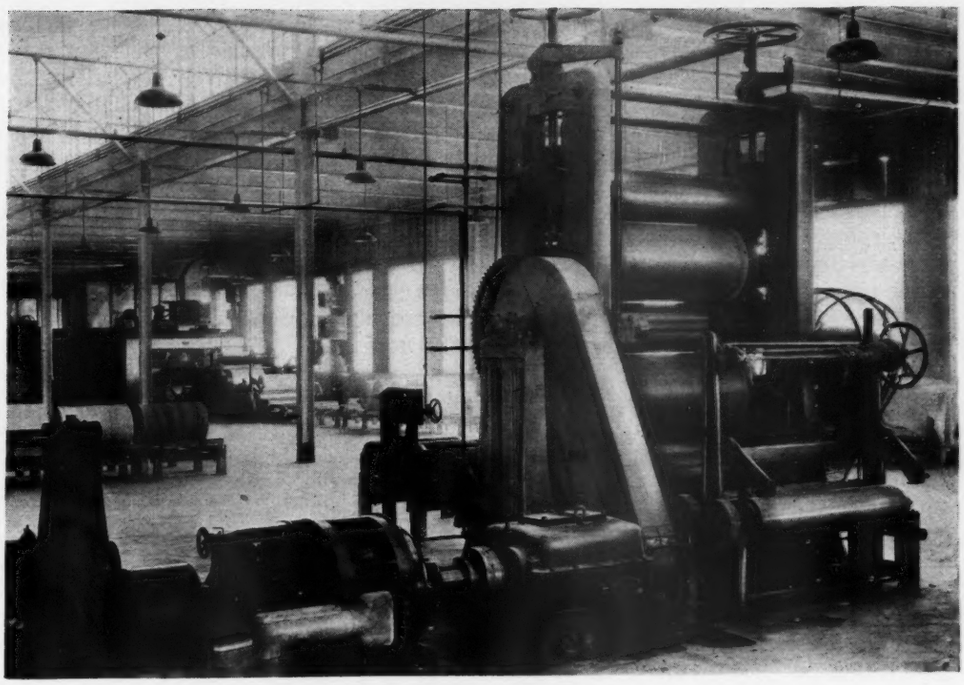
A multiple-spindle drill takes maximum power for a short time when all seventeen spindles are in cut; then fifteen finish their cut and revolve idly while two drill deeper holes to be tapped for studs. There is, by the way, a considerable momentary peak as the drills break through.

A turret lathe or a screw machine appears to impose a uniform load, but let us watch it. This turret lathe takes a forming cut, then drills, reams, threads, faces, and cuts off. The forming cut requires several times as much power as the other operations and there is considerable idle time while the tools are backing out and the head is coming around. Then, there is the loading time if it is working on forgings, not rod stock.

Over here we see a slab miller; that looks like a uniform load, but examination shows that at the ends of the cut it finishes the whole width of the piece; the other nine-tenths of



Figs. 1 to 4—Power requirements of machine tools often vary widely during the duty cycle. In Fig. 1 is shown a graphic wattmeter chart from the motor driving a punchpress. Each group of peaks represents one strip of stock. The power record of a cam-grinding machine is shown in Fig. 2. Power consumed in grinding one cam is represented by each of the groups of peaks. The friction load of the machine is shown at "A." A turret lathe gave the chart in Fig. 3. Friction load is shown at "A." At "B," rough-turning, facing and boring; "C," indexing load; "D," finish turning, facing and boring; "E," reaming a $\frac{3}{4}$-in. hole. Fig. 4 was obtained from a gear-hobbing machine. Note at "A" the decreasing load as the cut is finished. These charts were taken from an article by W. W. Nichols in the December, 1928, issue of the S.A.E. Journal.



Specific requirements of some types of machines can best be met by individual drive. This five-roll combination friction and rolling calender in a Southern textile mill is driven by a 50/16.67-hp., 1,000/333-r.p.m., brush-shifting a.c. motor, using a speed reducer and chain drive to obtain the required roll speed.

the time only a narrow pad at each edge is undercut. When the whole table full of pieces is finished there is idle time returning the table and reloading the jig.

Most presses and similar machines require a larger motor to bring the flywheel up to speed in starting than is needed thereafter. Frequently a 100 per cent larger motor is needed even when one with a special high-resistance rotor is used. Many machines take less power on the return stroke than on the cutting stroke.

The following day "hard" castings may be in the machine shop. These will increase the loads on some types of machines and decrease them on others. Similarly, scant seasoning or abnormally thick, rough lumber puts abnormal loads on woodworking machines, sometimes for a full day or longer. Overload capacity, particularly on 55-deg. C. motors, will not bridge over such periods.

In Figs. 1 to 4 are shown a number of graphic meter charts illustrating the variable power demand of ordinary, representative machine tools. Note that in Fig. 4 the gear hobber, in spite of its apparently uniform load, shows a variation of 50 per cent of maximum load over a five-minute interval.

A considerable allowance in motor capacity must be made for abnormalities of raw material and for dull tools. Abnormal reduction from oversize stock in woodworking, accompanied perhaps by dull cutting knives; abnormally hard or tough castings or forgings; abnormal depths of cut due to worn drop dies or unexpected casting warpage—the motor must handle all such abnormalities. It is difficult enough to keep up production under such conditions without having a motor "roast out."

Let us now consider the case of machine tools and similar equipment where these conditions are met:

1. Handling moderately heavy, not light work, where the average machine requires, say, a 3-hp. motor.

2. Every machine tool is used on a single job throughout its life.

3. Every machine is tested with dull tools and under similar handicaps and the motor size determined from the results of this actual test, with due allowance for the short-time overload capacity of the motor and the observed duty cycle.

Under such favorable conditions, almost never realized in commercial practice, motors having a capacity 100 per cent in excess of the average load demand on a 40-deg. C. rise basis, or 140 per cent excess capacity on a 55-deg. C. rise basis, would be just about sufficient on the average to carry the peaks without stalling and to carry the loads due to hard stock, dull tools, machine stiff after overhauling, and other abnormalities, without roasting out. Of course, there will be some variation above and below this figure according to the type of machine. These allowances would be a trifle less if it were always possible to select a motor of the exact capacity desired. If a 2-hp. motor is too small it is necessary to go to a 3-hp. rating. Probably this situation is seldom of much importance. It is uncommon for the plant man to know what he needs so closely that he is handicapped by this fact. Motor sizes for individually driven machines must ordinarily be determined before the machine is delivered. Few machines operate for their life on a single piece part.

On lighter work where a 1-hp. motor or smaller is sufficient for the average machine, conditions are less favorable. In most cases if the machine is fairly intricate the greater part of the power input is used in overcoming its own friction. Periodically the machine is overhauled, the bearings taken up or bushed, lost motion taken up in slides, and worn parts renewed. After such an overhauling a machine is likely to be stiff.

Inasmuch as the power requirements running light and loaded differ but little, the driving motor must be liberal in capacity to loosen up such a machine. In many cases it is given only an hour or two of operation without load—just long enough to make sure that nothing heats up dangerously—and must then return to service. How many times we hear, "That little machine used to have a ½-hp. motor, but I had to put a 1-hp. on it. It would run all right on a ½-hp. motor when everything was just OK., but the motor burned out every time the machinists worked on it."

For this lighter class of machines somewhat more allowance is necessary than described above for heavier work, although it is difficult to generalize. Conditions on a knitting machine and on a sensitive drill are different. Probably a fair average allowance for 40-deg. C. motors would

be 150 per cent normal capacity greater than average requirements, or 200 per cent excess capacity for 55-deg. C. rated motors.

All the above discussion is based upon applying to each machine at all times the proper size of motor for the piece part assigned to it, as closely as the commercial line of motor sizes allows. However, the exactly proper motor never is applied to every machine, never has been applied to every machine and I fear never will be applied to every machine until that happy time when the lion lies down with the lamb and the little child leads them. Then I assume that manufacturers will cease to make style and model changes in their products and all engineers will be gifted with perfect judgment.

When purchasing a special-purpose machine tool to work on one part alone an engineer must estimate the power required from a blueprint of the piece to be machined, and a knowledge of the material. Some men, very few indeed, are particularly good at this sort of educated guessing. From the estimated production per hour (modified by their knowledge that the machine will be speeded up after installation, if practicable) the cubic inches to be removed per minute, and data on previous jobs, they can estimate with remarkable exactness on a few types of machines. I have never known a man who could estimate closely on the whole variety of machine tools in a manufacturing plant.

Due to lack of confidence in their ability to estimate power requirements accurately and to press of other work when planning the retooling of a plant, many plant engineers leave specification of motor sizes to the machine tool manufacturer. The majority of builders then furnish a motor that will handle the maximum load capacity of the tool. It is seldom commercially possible for either the purchaser or builder to delay the selection of motor size until the machine can be tested in service.

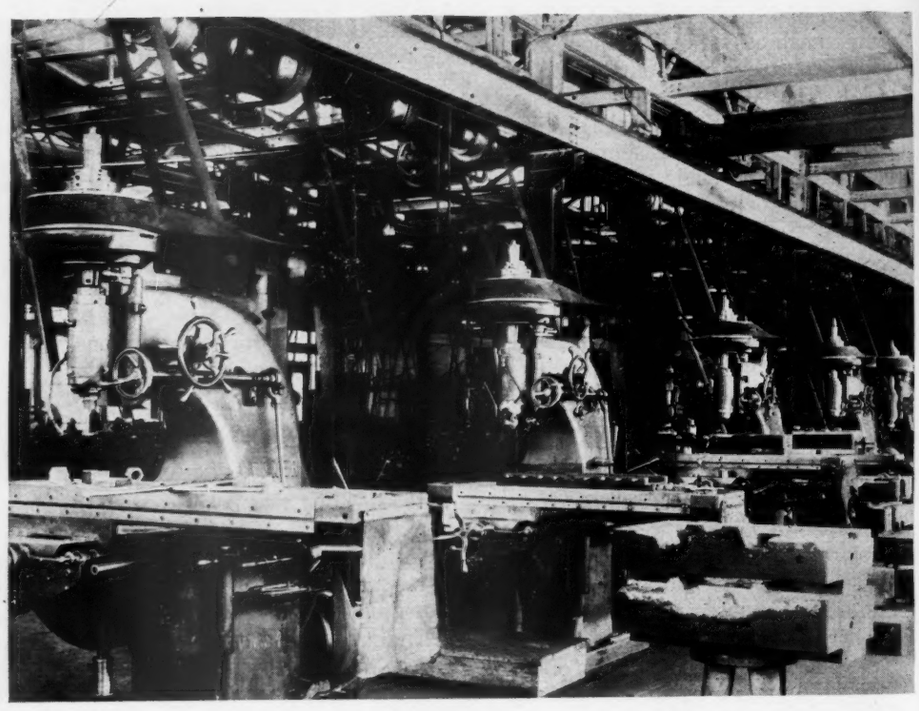
The result is that most machines are overmotored at first. The most glaring misfits are sometimes corrected by changing motors afterward when the shop is in production and tests are possible. In relatively few plants of small and medium size is this routine practice. Even when such tests are made and desirable changes indicated, they are likely to be indefinitely postponed for two reasons:

First, in a considerable proportion of cases a smaller motor will not fit in well, particularly on machines with built-in motors.

Second, there is the ever-present thought of what may happen "when the new model is brought out." The engineer thinks, "As likely as not this motor will fit the job next year, or the next. I can't change motors on all machine tools every time the piece part is changed. Half the time I would be obliged to change back the following year. Where the existing motor is too small for the new job, of course, I must change it. That is all the more reason for leaving where they are these that are a little large. It doesn't pay to change so many motors every year or two."

In many cases he is right. It does not pay to change small, individual-drive motors frequently. The cost of labor, planning, blocking, new pinions or sprockets (there is seldom time for boring and bushing, nor does this save much at overtime rates) perhaps a new bracket, with the labor and electrical material, is so great that on motors below 15-hp. rating an overtime change costs half as much as the first cost of the motor removed. This expense is not warranted unless the motor is several sizes too large, or unless there is a reasonable certainty that the load will not vary enough to require another change for a number of years, varying from three to five years for a 10-hp. motor to twenty years or more for the 2-hp. sizes.

It appears that under many conditions it may not pay to fit small motors too closely, but that does not alter the fact that a large proportion of misfits, more than 50 per cent in fact, will exist in any individual-drive plant.



Usually it is not feasible to use group drive in areas served by overhead cranes, but in a large automobile plant the problem of group driving a number of machines that require crane service has been solved by the arrangement shown here.

The above discussion pertained to special-purpose machines. Only the exceptional manufacturing plant has sufficient volume of business to keep a complete machine tool equipment busy the year around on identical piece parts. The larger automobile plants no doubt do it, but even they may change jigs and make parts for the light six and the big eight on

the same machines. Of course, they must be motored for the heavier of the two jobs.

In ordinary manufacturing plants a considerable proportion of the machines is used at one time or another on a variety of parts. There may be a seasonal variation in product—lawn swings in the spring and snow shovels in the fall; women's coat material and automobile upholstery. There may be a variation with style changes. At any rate there is not enough work of one kind available so that the majority of machines can be kept on identical work the year around, year after year. They may be kept on similar work, but if individually driven the motors will be grossly underloaded when the machines work on the smaller sizes.

Group drive is well adapted to much of the light machinery used in making shoes. Although the lineshaft and machines are placed close to the windows there is no noticeable interference with the natural lighting.

Many plants, large as well as small, approach jobbing in variety. Parts for auto accessories, radio parts —whatever they can obtain a contract for is grist for their mill. In such a plant there is nothing to do but to motor individually driven machines heavily enough to develop the full capacity of the machine on the largest job at the highest speed in the toughest material.

Can group-drive motors be kept loaded all the time? No, but the situation is entirely different than in the case of individual drive. There will be many misfits among the motors driving the groups in a new plant, just as there will be among the individual-drive motors. It is not to be expected that final selection of motor sizes for all groups can be made before the plant starts. No plant engineer can estimate closely the maximum horsepower requirements of a group from the blueprints of the pieces that are to be machined.

Errors in estimating the average power requirements of the machines in the group tend to cancel out, but this tendency is relative only. Everyone overestimates the requirements of groups, just as in the case of individual machines. Recurrent testing and motor moving are necessary if power factor is to be maintained near the maximum attainable value, either with group or individual drive. With group drive a smaller proportion of all motors must be changed yearly.

Changes in power requirements of the individual machines with minor changes in product due to improvements, model changes, and whatnot tend to offset each other on the different machines in a group. Furthermore, unlike most small individual-drive motors, group-drive motors are ordinarily so large that it pays to change them if underloaded even though there is a chance that the underload will persist for only two years.

Dull tools, oversize or tough stock, and machines stiff from recent overhauling seldom affect enough of the individual machines in a group to be of importance, although with identical machines working on identical products abnormalities of raw material may be general in their effect.

An increased power demand on some machines in a group, due to changes in design of the product, is frequently balanced by a decrease on others, or even more frequently by elimination of an opertion, and removal of a machine.

With ten to twenty or more machines in a group the cyclic variations in the power demands of the individual machines largely cancel out. The larger the group the more complete this evening of the load becomes. There are fewer group-drive motors, so that fewer moves are required and much less testing. Substitution of, say, a 30-hp. motor for a 50-hp. is not a great deal more costly than the substitution of a 3-hp. for a 5-hp. motor on an individually driven machine, whereas the saving is far greater. The former change will pay for itself in about two years; the latter requires ten years or more.

Group-drive motors are ordinarily belted. They can be changed without undue expense. The belts and pulleys removed will soon be used again. In a large plant this is true of the motors also. No special sprockets, chains, brackets, etc. are required.

There are few group-drive motors that need changing each year, so that the work is not a burden to the millwright and electrical crew. If they tried to change all the individual-drive motors that needed it, they would never finish if all hands worked every Sunday at that one job alone.

These, I believe, are the reasons why relatively fewer individually driven shops than group-driven shops

approach the maximum attainable power factor and the minimum connected motor load for the respective types of drive.

A common practice is to apply 40-deg. C. group-drive motors so that all are overloaded 20 to 30 per cent during the busiest season. This practice helps to keep down the investment and maintain a tolerable average power factor. During the busy season each year the motor tenders are required to turn in a list of the motors in their care that are never hot. In this way attention is called to the groups where changes in product and machine tool moves have materially reduced loads. A test follows, with a study of the probable conditions during the next year, and then motor moves are planned. Motors removed from one place are scheduled to go into another. If any new motors are required, they are small. A 2-hp. motor replaces an underloaded 5-hp.; the 5-hp. takes the place of a 10- or 15-hp., and so on up until a 50-hp. comes out and goes into spare stock until needed.

Such practice results in group-drive motor loads varying from 50 to 75 per cent of full load when a department is slack, up to 100 to 125 per cent load when the department is busiest. The motors are never operated above 50- to 55-deg. C. temperature rise. Of course, in a shop that operates a "unit," a "line," or a department at full capacity or not at all, the periods of reduced-load operation are absent.

Ordinarily, enclosed motors are unnecessary for group drives. In a few of the most unfavorable departments of a plant they may be advisable, but in the majority of locations standard, open-type motors will give acceptable service. Dipping and baking cares adequately for ordinary moisture and vapor conditions. The motors are high up out of danger from flying metal particles, grinder sludge, and cutting compound. Only where extreme dust conditions exist is enclosure necessary. Open motors cost less and have overload capacity that the enclosed motors operating at higher temperatures lack.

In some plants an effort has been made to lay out all groups to utilize motors of two or three sizes, in order to minimize the investment in spares.

In my opinion this is mistaken policy. In the first place it results in many underloaded motors, for machines are and must be grouped to suit convenience in manufacturing, not the chief electrician's standard motor sizes. There will be many groups containing only machines with small power requirements, many containing only machines with large power requirements. In the majority of cases the choice of machines to be included in the group will be dictated by considerations of floor space available, major interferences to group shafting (such as conveyors), and by manufacturing convenience.

Furthermore, as tests show motor changes to be desirable it is not to be expected that these will arrange themselves to suit a limited variety of motor sizes. To make and maintain an economical application of group drive it is evident that a considerable variety of motor sizes must be used.

The conclusions given in the box on the first page of this article pertain primarily to large plants with a rather high grade of engineering supervision. They were based on data from relatively few plants. The author lacks data concerning connected and maximum loads of smaller plants with the lighting load excluded. The data in Fig. 5 were obtained in an effort to find out how much installed capacity exceeds maximum demand in smaller plants. These data are not directly comparable with the data in the box on page 287 for the latter concern the plant motor load alone, whereas Fig. 5 includes the lighting load, electric heating or furnace load, if any, and the power load.

The 40 plants represented are all within the metropolitan area of a large city. There were no sawtooth roof or other single-story buildings. In general, natural light is limited and a heavy all-day lighting load exists at the time of maximum demand. In a few of the lighter industries the lighting load exceeds the power load.

Inasmuch as the peak lighting demand determines when the maximum plant demand occurs in many or most cases, it may safely be assumed that in almost all the 40 plants from 50 to 95 per cent of the total connected lighting load was being carried at the time of the recorded maximum demand. Allowing for this fact, it is evident that for all these plants the ratio of connected motor load to the maximum power demand of the motors is at least five to one, and probably is greater. Some of the 40 plants in question are individually driven; some are group driven.

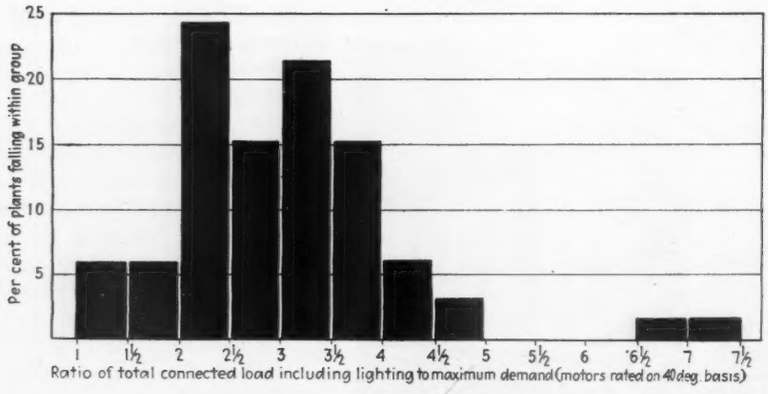
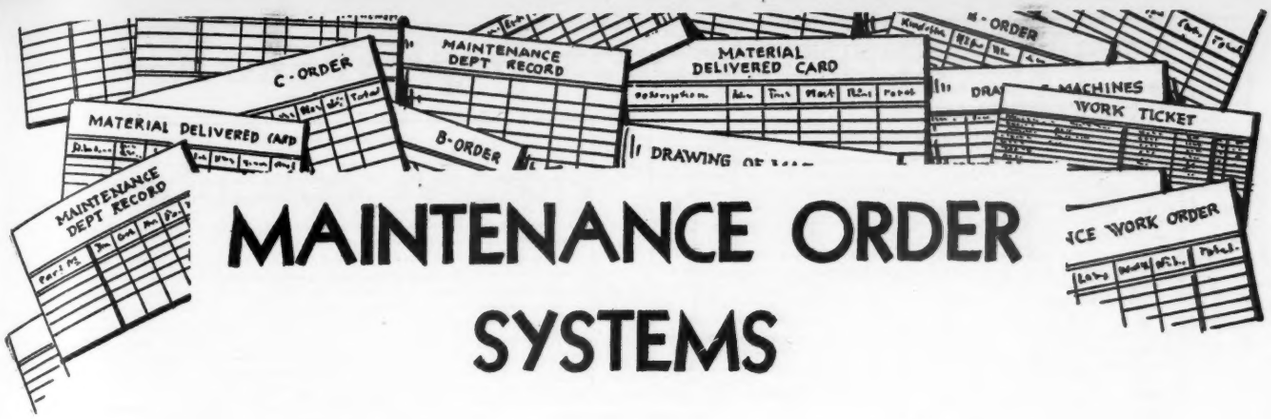


Fig. 5—Ratio of total connected load, including lighting, to maximum demand in 40 small- and medium-sized plants in various industries. Both group-driven and individually driven installations are included. The connected load, lights, motors and all electrical equipment, varies from 10 to 750 kw., with motors rated on the 40-deg. C. rise basis. The percentage of the total number of plants that fall within each ratio group is shown by the scale at the left. Thus, in 21.25 per cent of plants the ratio of connected load to the heaviest load actually occurring for 15 or 30 min. lies between 3 and 3½. The corresponding ratios for the motor loads along, lighting and other loads excluded, would in general be much higher, because in most plants 50 to 90 per cent of all lights are burning at the time of maximum total load.

Third article — next month — beginning a discussion of comparative performances of group and individual drives for six characteristic types of plants



MAINTENANCE ORDER SYSTEMS

Part VII—Prophesying Maintenance Costs

G. I. ROSS
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Boston, Mass.

IN AN INSTRUMENT plant of 850 employees, the maintenance foreman estimates the costs of work before an order is actually issued. The routine is as follows:

"Repair Orders" are used for all maintenance work except jobs that will exceed $25 in cost. "Plant Orders" are issued for the latter.

The Repair Orders are issued by the Plant Engineer's Office without further approval, but the plant orders must receive the approval of the Factory Manager in addition to that of the Plant Engineer.

Repair Orders are issued in duplicate (Fig. 8), the original going out on the job, and the duplicate, of heavier paper, remaining in the Plant Engineer's Office.

All requests for maintenance work are submitted to the Plant Engineer's Office on AVO* form whenever possible. The Plant Engineer's clerk, upon the receipt of this request, issues a Repair Order covering the work to be done and forwards it to the Maintenance Foreman who will later perform the work. The latter surveys the job and reports back to the office his estimate of the time which will be required to perform the work and also the material which will be needed. This is listed on the reverse of the original of the form. If the material and labor do not total more than $25 the Plant Engineer's clerk requisitions the necessary ma-

In this article Mr. Ross proceeds from the general problem of maintenance cost control, discussed last month, to a specific case — the order system used in a plant of 850 employees, manufacturing instruments.

*AVO: "Avoid Verbal Orders."

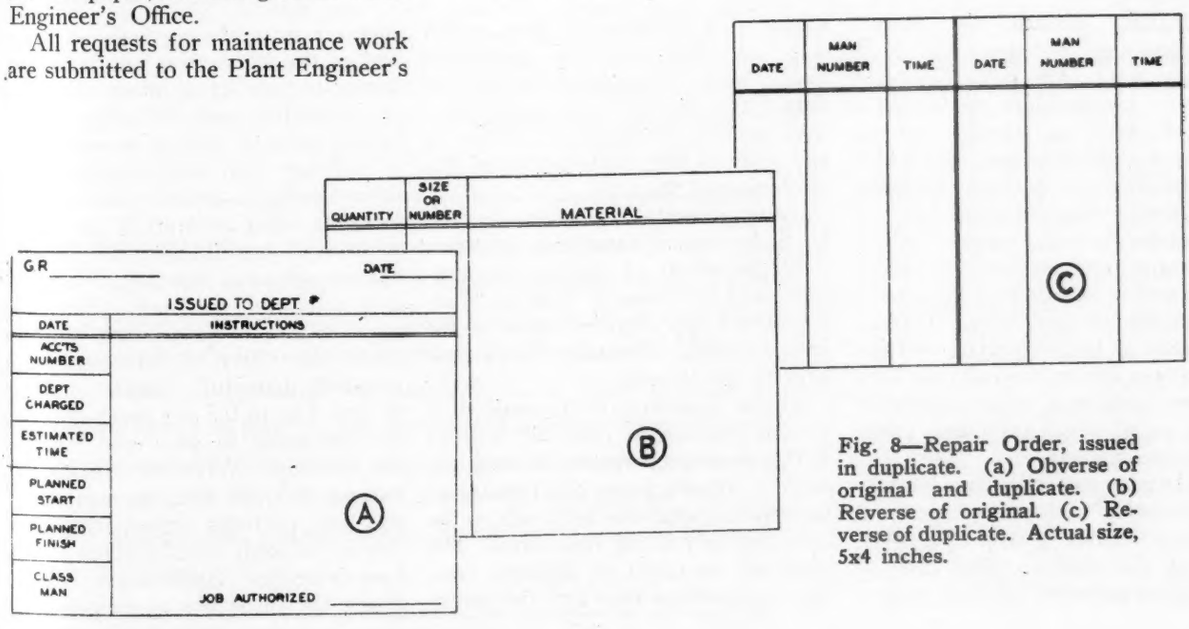

Fig. 8—Repair Order, issued in duplicate. (a) Obverse of original and duplicate. (b) Reverse of original. (c) Reverse of duplicate. Actual size, 5x4 inches.

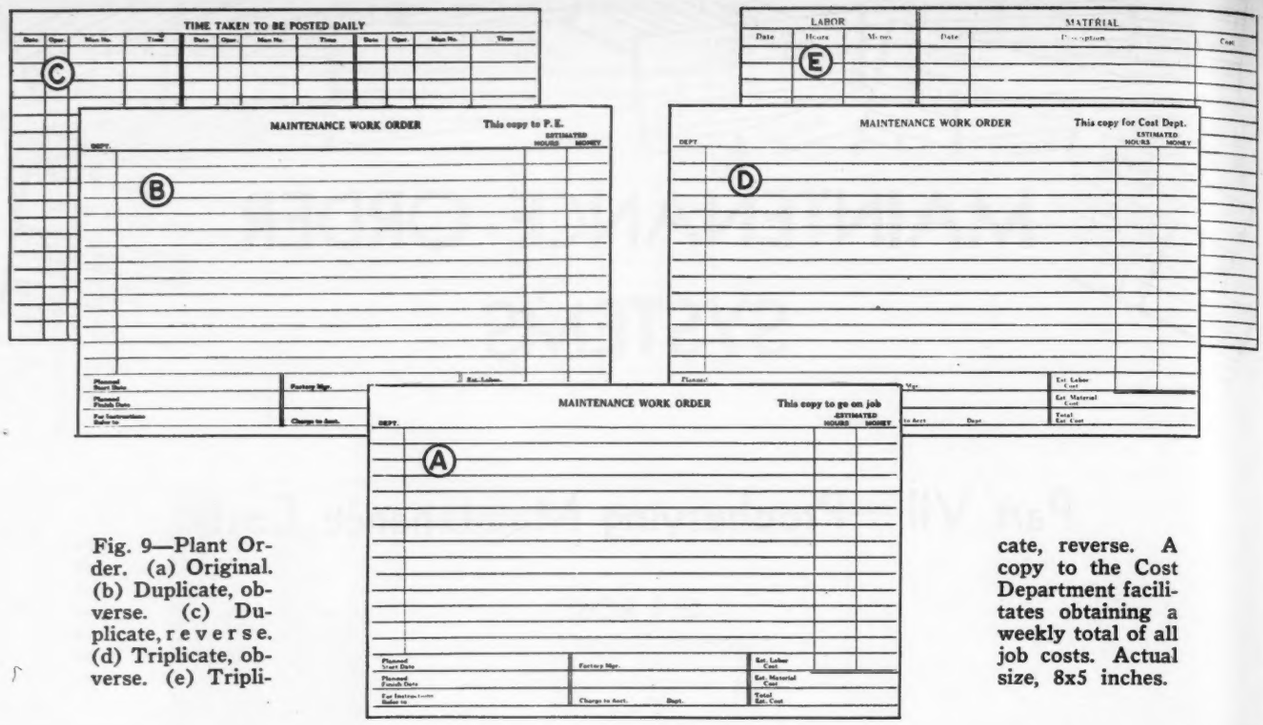

Fig. 9—Plant Order. (a) Original. (b) Duplicate, obverse. (c) Duplicate, reverse. (d) Triplicate, obverse. (e) Triplicate, reverse. A copy to the Cost Department facilitates obtaining a weekly total of all job costs. Actual size, 8x5 inches.

terial and places the job on the maintenance schedule in its proper sequence with the other jobs.

When, according to the schedule, the work is to be started, the original of the form is again sent to the department foreman and he retains it until the work is completed. He then sends it to the Plant Engineer's Office.

At the end of each week the Plant Engineer's clerk compiles a list of all jobs completed, showing number of jobs on hand at the end of the previous week, number on hand at the end of the current week, number completed during the week, estimated job costs, and the actual cost of the completed jobs. The Plant Engineer uses this report as a control on the output and efficiency of the Maintenance Departments.

Plant Orders are handled in much the same manner as described above except that the form (Fig. 9) is issued in triplicate, one copy going to the Cost Department. This department assigns a job number to the order, and at the close of each week the labor chargeable to the job is reported under this number by the Plant Engineer's clerk. In this way the Cost Department maintains a weekly total of all Plant Order job costs. These are submitted in suitable form to the management.

With this article is concluded the discussion of maintenance work in plants of less than 1,000 employees. Next month the maintenance problems arising in a plant of 2,500 employees will be considered.

■ ■

Effect of Casting Temperature and of Additions of Iron on Bearing Bronze

WHILE "bronze" is, strictly speaking, a copper-tin alloy, this term now covers a multitude of copper-tin compositions containing a third or even a fourth element. Among the elements that are added zinc and lead are perhaps the most widely used in bearing bronzes.

A bronze bearing material which has become very popular and which has proved its usefulness in service, is the copper-tin-lead alloy. This alloy, known as leaded bronze, contains hard copper-tin compounds, as hard as some steels, in a softer copper-tin matrix, all of which surrounds particles of uncombined lead. Many successful bearing materials have a structure consisting of hard particles, imbedded in a softer matrix. The plasticity of the matrix takes care of small misalignments of the bearing shaft. The presence of lead, which does not alloy with the copper-tin matrix to any appreciable extent, assists materially in reducing the friction, renders the bronze more plastic, and aids in the manufacturing and machining of the alloy.

Tests recently conducted by the U. S. Bureau of Standards to determine the effect of casting temperatures and additions of iron on bearing bronze are reported upon in the January, 1932, Technical News Bulletin of the Bureau.

In the founding of bronzes it is seldom possible to pour all castings at the same temperature, because the metal is drawn from the furnace at various temperatures and cools in the ladle during pouring operations. The study of the effect of different casting temperatures thus aids the manufacturer in producing better castings and at the same time helps the consumer by predicting what variations in properties may be expected of bronzes cast at various temperatures.

Although iron is not usually added intentionally to leaded bronzes, small amounts often accumulate during the process of manufacture through the use of scrapped bearings, iron stirring rods, and so forth. While the iron content is quite small in most cases, the effect of this element is generally harmful. Small additions of iron (up to 0.5 per cent) decrease the resistance to wear and increase the hardness. When the iron content exceeds 0.3 per cent, segregation of the lead particles occurs, the grain size is reduced, and the notch toughness decreases. Additions of iron increase the resistance to pounding.

Dual-Voltage Connections for Induction Motors

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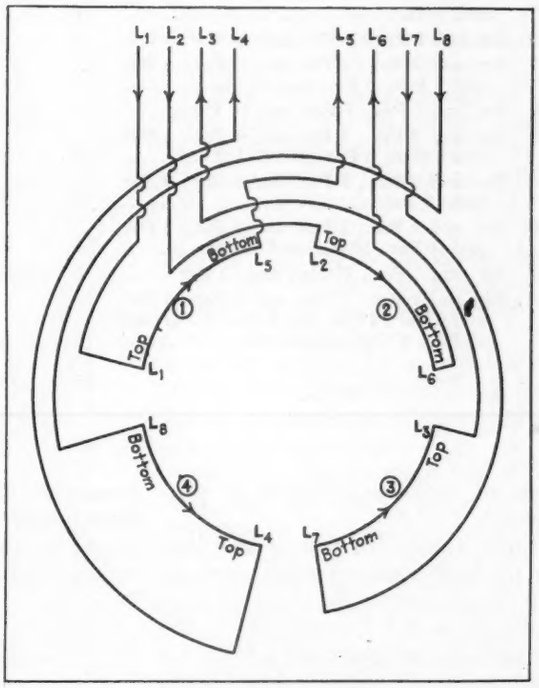


Fig. 1—Standard line-type diagram of a two-pole, two-phase winding with eight leads brought out for high-voltage (series) or low-voltage (two-parallel) connections. For the line connections see Table II.

IN THE March, April, May, and June, 1923, issues of this publication (then known as *Industrial Engineer*) the subject of connecting diagrams and coil grouping for two- and three-phase, lap-wound induction motors was covered in detail. Most of the material covered the line type of diagrams for single-voltage connections, although two-speed and other special connections were referred to. Mention was also made of, and a few sample diagrams given for, connections that permit external reconnection of the motor for two line voltages.

The scheme of bringing out a number of leads from a winding to permit its use on 110 and 220, or 220 and 440, volts was first used principally with single-phase repulsion-type motors. Now it is being used to a great extent on two- and three-phase induction motors that use a lap winding.

The basic idea is that any one winding is designed for two voltages, hence the term dual. The connections are selected for each winding that will develop each voltage when the outside leads are properly grouped and connected together.

To bring the previous material up to date, this series of articles will discuss dual-voltage, schematic line diagrams for lap-wound induction motors. The diagrams to be shown are of a new type, based on the schematic outline used with the line-type diagram. Diagrams and coil-grouping charts in "Repair Shop Diagrams" by Braymer and Roe can be used in conjunction with these dual-voltage diagrams.

The present article covers the two-pole, two-phase connections. Table I lists the total number of different connections possible with two to 24 poles. For example, with two-pole windings there is only one diagram for each phase and type of connection: (1) Two-phase, series and two parallel; (2) Three-phase, series and two-parallel star; (3) three-phase, series and two-parallel delta. For four-pole motors there are two possible connections: (1) series and two-parallel, also (2) two-parallel and four-parallel, and so on.

In the dual-voltage diagrams covered in this series there are three basic factors. (1) Eight leads are brought out from all two-phase windings. (2) There are three tables, Table II for two-phase, Table III for three-phase star, and Table IV for three-phase delta connections, that show how the external motor leads should be connected to the line. (3) The schematic-line type of diagram for each connection shows the location of each pole-phase group with reference to the line leads and other pole-phase groups. Fig. 1, illustrating the two-phase, two-pole, series and two-parallel connections, refers to Table II which shows how the line

WINDINGS of induction motors are more frequently changed to accomodate them to a different voltage than for any other reason. Formerly such changes necessitated reconnection of coils or coil groups in order to keep the voltage on each coil substantially the same as in the original design. It is now becoming practice for manufacturers to group the coils of lap-wound motors so that they can be operated on either of two different voltages merely by changing the external connections. In a new series of articles, of which this is the first, A. C. Roe will show how the windings of 2- to 24-pole, two- and three-phase motors can be arranged for dual-voltage operation.

TABLE I — ALL POSSIBLE DUAL-VOLTAGE CONNECTIONS 2 TO 24 POLES. TWO- AND THREE-PHASE

No. of Poles	Possible Connections	Two Phase	Three-Phase Star	Three-Phase Delta	Total
2	Series and 2 Parallel	1	1	1	3
4	Ser. and 2 Par., 2 Par. and 4 Par.	2	2	2	6
6	Ser. and 2 Par., 3 Par. and 6 Par.	2	2	2	6
8	Ser. and 2 Par., 2 Par. and 4 Par., 4 Par. and 8 Par.	3	3	3	9
10	Ser. and 2 Par., 5 Par. and 10 Par.	2	2	2	6
12	Ser. and 2 Par., 2 Par. and 4 Par., 3 Par. and 6 Par., 6 Par. and 12 Par.	4	4	4	12
14	Ser. and 2 Par., 7 Par. and 14 Par.	2	2	2	6
16	Ser. and 2 Par., 2 Par. and 4 Par., 4 Par. and 8 Par., 8 Par. and 16 Par.	4	4	4	12
18	Ser. and 2 Par., 3 Par. and 6 Par., 9 Par. and 18 Par.	3	3	3	9
20	Ser. and 2 Par., 2 Par. and 4 Par., 5 Par. and 10 Par., 10 Par. and 20 Par.	4	4	4	12
22	Ser. and 2 Par., 11 Par. and 22 Par.	2	2	2	6
24	Ser. and 2 Par., 2 Par. and 4 Par., 3 Par. and 6 Par., 4 Par. and 8 Par., 6 Par. and 12 Par., 12 Par. and 24 Par.	6	6	6	18
	Total	35	35	35	105

leads of the motor should be connected.

From Table II it will be seen that for the high-voltage (series) connection the winding in Fig. 1 would have leads *L1* and *L3* connected to the *A1* and *A2* line leads, and *L2* and *L4* connected to *B1* and *B2;* then *L5* and *L7* are connected together, and *L6* and *L8*.

Schematic line-type diagrams are an evolution of the line diagram, Fig. 1, and the separate schematic diagram of Fig. *2A*. The schematic sketch has always been used in the past to show the group sequence and direction of current flow in all pole-phase groups. It is easily understood and is quite simple to construct. However, it has lacked sufficient data to permit its use as a working connection diagram. Through careful study I found that the schematic diagram could be combined with the line type to make a simple working diagram.

Two-Phase Schematic Line Diagrams

The schematic, line type of diagram has a few simple rules peculiar to itself, but it is based on the rules governing the standard line type of diagram, with the all-in direction arrow check. To facilitate a thorough understanding of the schematic line diagram, both types will be considered at first and the method of constructing the new type will be outlined.

In Fig. 1 is shown the standard two-pole, two-phase, dual-voltage, series and two-parallel line type of connecting diagram, with each pole-phase group numbered and a symbol placed at the beginning (top) and ending (bottom) of each pole-phase group to indicate the proper location of leads or jumpers. In Fig. *2A* is shown the schematic sketch for Fig. 1, with the wavy lines representing a pole-phase group. The direction arrows indicate only the *current flow from lead to lead,* not the current flow in any one pole-phase group as, in the line diagram of Fig. 1, from top to bottom or bottom to top.

To make the schematic diagram of Fig. *2A* indicate the polarity of each pole-phase group, the groups can be rotated 90 deg., as in Fig. *2B*. The curved, dotted lines in Fig. *2A* indicate the direction in which each group should be turned.

These rules should be kept in mind:

Rule 1. The direction of current flow in groups *1* and *2* is based on the line diagram rule that the current flows into the winding along the *L1* and *L2* leads, and from top to bottom or left to right in pole-phase groups *1* and *2*. This starts the first group of each phase correctly.

Rule 2. To arrange the remaining groups of each phase properly, each succeeding group of the same phase should be arranged under the preceding group with the top lead of the

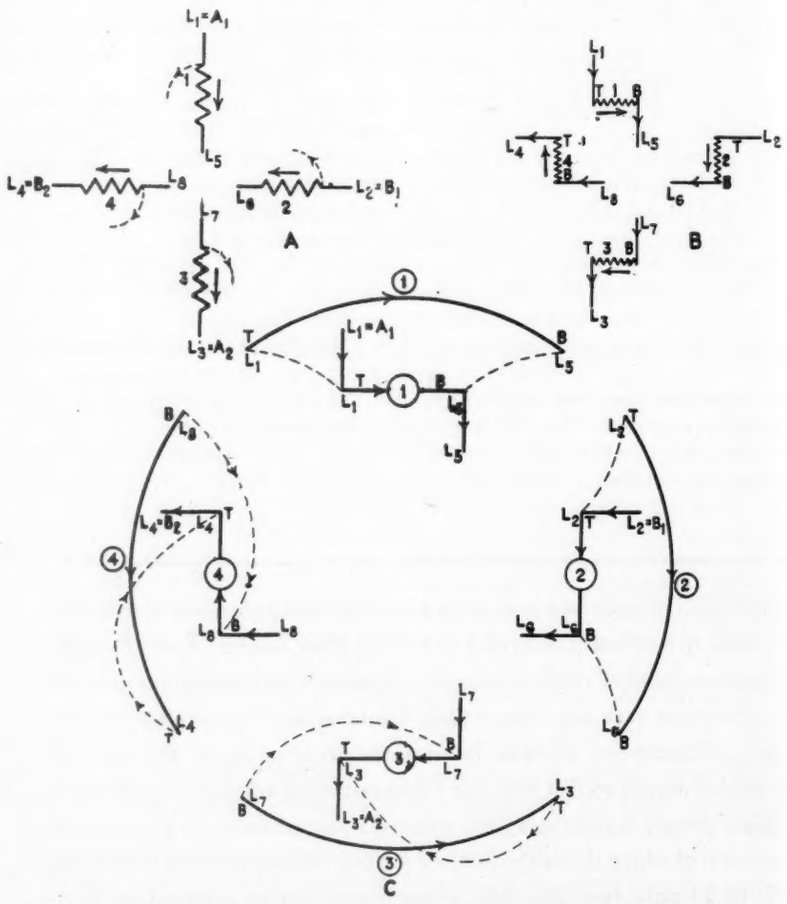


Fig. 2—Schematic line diagram of a two-pole, two-phase winding showing how it is derived from the conventional diagram (Fig. 1) and the schematic diagram, "A."

TABLE II — CONNECTIONS OF LINE AND MOTOR LEADS FOR TWO-PHASE MOTORS ALL POLES

High-Voltage Connection.....	L1 connects to A1 line L3 connects to A2 line	A-Phase
	L2 connects to B1 line L4 connects to B2 line	B-Phase
	Connect L5 and L7 together Connect L6 and L8 together	
Low-Voltage Connection.....	L1 and L7 connect to A1 L3 and L5 connect to A2	A-Phase
	L2 and L8 connect to B1 L4 and L6 connect to B2	B-Phase

TABLE III — CONNECTIONS OF LINE AND MOTOR LEADS FOR THREE-PHASE STAR CONNECTIONS ALL POLES

High-Voltage Connection....	Line Leads to L1, L2, L3 Connect L4 and L7 together Connect L5 and L8 together Connect L6 and L9 together
Low-Voltage Connection.....	Connect L1 and L7 to B phase line Connect L2 and L8 to C phase line Connect L3 and L9 to A phase line Connect L4, L5, L6 together (outside star)

TABLE IV — CONNECTIONS OF LINE AND MOTOR LEADS FOR THREE-PHASE DELTA CONNECTIONS ALL POLES

High-Voltage Connection.....	Line Leads to L1, L2, L3 Connect L4 and L7 together Connect L5 and L8 together Connect L6 and L9 together
Low-Voltage Connection.....	Connect L1, L6, L7 to B phase line Connect L2, L4, L8 to C phase line Connect L3, L5, L9 to A phase line

group on the left or directly under the top lead of the first group. Thus the groups are in proper relation for a bottom-to-bottom and top-to-top connection, as Fig. 2*B* shows.

In Fig. 2*C* is shown a schematic line diagram constructed inside a line diagram similar to Fig. 1, except with jumpers or leads omitted for clearness. Note that groups *1* and *2* are in the same relative positions and the direction arrows are the same. Groups *3* and *4* of the line diagram have been rotated 180 deg. for the schematic diagram in order to make these groups, when placed under groups *1* and *2*, have opposite polarity, or groups *1* and *3*, *2* and *4* have the tops in line.

Rule 3. A positive check on the correctness of any two-phase schematic line diagram is that the first and last groups of phases A and B should form the outer sides of a square with all arrows pointing clockwise around the square, as in Fig. 2. With this rule established the polarity of each succeeding group should be reversed, as with line diagrams.

Rule 4. With dual-voltage diagrams each phase is divided into two sections and two leads are brought out from each section, four leads per phase, or eight leads per motor. The starting lead of the A phase is *L1* and is always the top lead of group *1*. The finishing lead of the A phase is *L3* and comes from the top of the last group. Thus the starting and finishing leads of the phase connect to the top of the groups.

Rule 5. The finishing lead of the first half or section of the A phase is *L5* and connects to the bottom or top (see rules 10 and 11) of the last group of the section. The starting lead of the second section of the A phase is *L7* and connects to the bottom or top (see rules 10 and 11) of the first group of the second section.

Rule 6. On leads *L1* and *L7* (see Figs. 1 and 2) the arrows should point into the winding, whereas on leads *L3* and *L5* the arrows indicate the current as flowing out of the winding.

Rule 7. Likewise for the B phase, *L2* is the starting lead, and connects to the top of group *2*, the arrows pointing into the winding. The finishing lead is *L4* and the arrow points away from the winding, lead *L4* being connected to the top of the last group in the phase.

Rule 8. The finishing lead of the first half of the B phase is *L6*, attached to the bottom or top (see rules 10 and 11) of the last group of the first section, the arrow on *L6* pointing away from the winding. The starting lead *L8* of the second half is connected to the bottom or top (see rules 10 and 11) of the first group, with the arrow on *L8* pointing into the winding.

Rule 9. The direction of the arrows on leads *L1, L2, L3, L4, L5, L6, L7,* and *L8* is important because it determines the proper end of a group that should be connected to a jumper when constructing a parallel connection. This point will be explained later. Tables II, III and IV show how the leads in the dual-voltage diagrams are connected to the line. The terms high voltage (HV) and low voltage (LV) are applied to each diagram in order to permit proper selection of leads for each voltage condition.

THE NEXT article, which will appear in an early issue, will discuss the factors common to four- to ten-pole, two-phase, schematic-line, dual-voltage diagrams, and parallel connection diagrams.

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

JULY, 1932

■

A Bitter but Beneficial Pill

IN SOME plants pared maintenance budgets have changed the job of the maintenance engineer from that of the white collar executive to a combination of executive and foreman.

Disheartening though this condition may be, it is not without its advantages. To those optimistically inclined it affords an opportunity to gain a fuller appreciation of the tasks and problems of their subordinates. Such men do not feel that their positions have lost any of their former dignity but rather that, when better times permit them to return to purely executive work, they will have increased the breadth of their experience.

The added duties present to the technically trained engineer who is short on practical experience an opportunity to remedy the deficiency.

To the maintenance engineer who has worked himself up through the shop the changed job offers a chance to review his experience under today's modern conditions.

■

Need Ideas?—Modernize Your Suggestion System

DO YOU remember that suggestion box you put up a number of years ago? At first you were flooded with ideas and then they began to drop off until your system died. Maybe you thought the reason for your dearth of suggestions was that your men had run out of ideas. Not a bit of it! Your men on the job are a constant potential source of money saving schemes.

What you need is a 1932 model suggestion system that will arouse enough interest, enthusiasm, and incentive in your men to bring forth a steady stream of suggestions.

The preceding paragraphs are the gist of the paper presented by W. E. Fisher, Industrial Research Department, University of Pennsylvania, at the recent 3-M Congress of the A.S.M.E. in Detroit, Mich., entitled "Maintaining Interest in Suggestion Systems." To quote from his paper: "The principal reason for the failure of suggestion systems in more than 50 per cent of the companies investigated was due to the way in which the suggestions were handled by the management . . . much of the lack of interest on the part of employees goes back to the mistakes made when the system was just installed. Many managements do not fully appreciate that not only the products and services to customers, but the methods, systems, and ideas that affect the organization should be carefully merchandised and intelligently sold."

Cardinal features that sell and keep sold successful suggestion systems are employee participation on the suggestion committee; regular publicity in the form of bulletin boards, plant papers, and posters; periodic meetings; and adequate awards, either financial or otherwise.

■

Factory-Made Weather Is Coming

DURING the next few months industry in general will again learn that when temperature and humidity go up, personal efficiency and production go down. Hot weather and high humidity may be fine for picnics and ball games, but they collect a heavy toll from workers and industrialists alike. In winter, so do the damp chill of cold workrooms, and the bone-dry air of stuffy, overheated offices and shops.

The influence of atmospheric conditions on the efficiency of workers is much more than a matter of personal discomfort, although that is an important factor. There are definite physiological responses by the body to temperature and moisture that control its activities and functioning to a greater degree than is commonly realized. Wrapped up with these immediate responses is the highly important matter of the effect of unfavorable environment on the health.

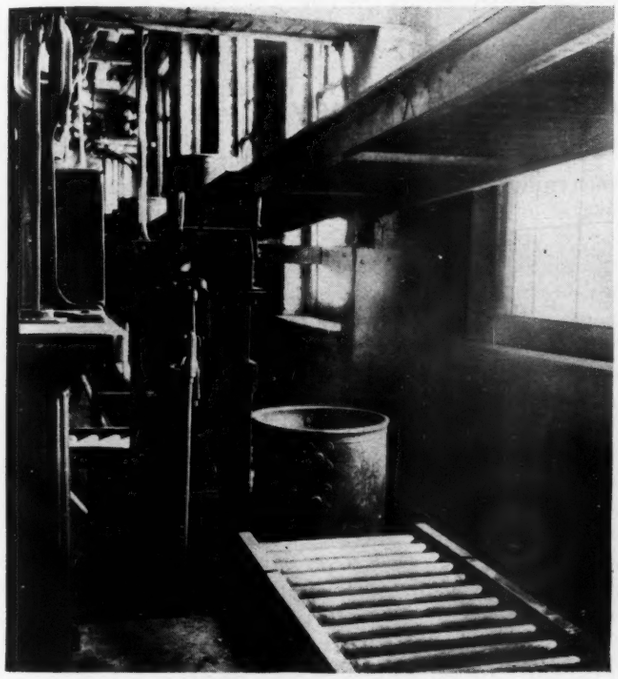
A great amount of experimenting and observation have given enough data for an intelligent appraisal of the importance of closer control of atmospheric conditions in factories and homes, shown what needs to be done, and disclosed how some of the problems may be solved.

Efficient equipment is now available for conditioning the air in all working places. Some day atmospheric conditions in our factories and offices will be always pleasant, healthful, conducive to maximum effort, regardless of weather conditions. The machinery for producing that condition is here; it remains for industry to adopt it.

MAINT-O-GRAPHS

Ways of increasing efficiency of equipment ◆ Ideas that will help plant men
News of books and events ◆ ◆ Practical solutions of plant problems
Unusual developments in apparatus design

CONTRIBUTIONS ARE WELCOME



Transfer Lift Joins Conveyor Lines

WILLIAM HOLD, *Maintenance Foreman*
National Lockwasher Company, Newark, N. J.

In order to provide the necessary slope for operation of a long line of gravity roller conveyor extending between the cutting and hardening departments in our plant, it was necessary to drop the lower end below floor level. Because it was desired to deliver the 450-lb. drums filled with steel parts to the hardening department at a height about one foot above floor level the lift shown in the illustration was devised to elevate and transfer the drums from the low to the high section of conveyor. The intervening distance is about four feet.

The lift consists essentially of a 1-hp. motor, and an arrangement of sheaves and cable. The cable ends are attached to a platform of gravity roller conveyor about two feet long. The gears reduce the motor speed enough to give a lifting speed of about 20 ft. per min. The unit is controlled by drum and limit switches so that, when the drum switch is thrown in the right direction, the platform and container are raised or lowered from one height to the other. When the lift reaches the end of its travel so that the platform is flush with, and connects, the lower or upper conveyor line a limit switch stops the lift, and the platform is locked in position.

Characteristics of Rubber, But Made from Chemicals

"Thiokol," a chemical product, is a recent competitor of rubber. It is said to have practically all the characteristics of rubber, but not to be affected by the same solvents. Made entirely of chemicals, there is no rubber in its composition.

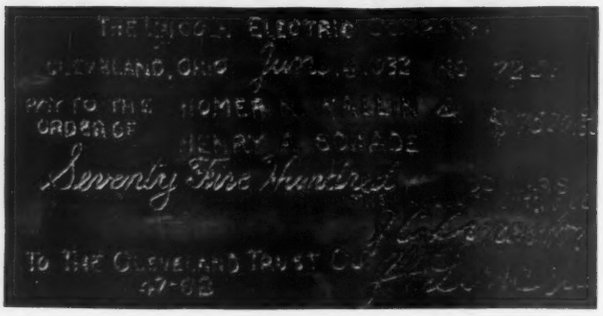
Claimed is an unusual resistance to the deteriorating action of most gases and liquids, particularly gasolines and oils. A prominent automobile manufacturer has been using it for a year in the form of tubing to convey gasoline to the carbureter. Claimed, also, are no or low deterioration by aging; no apparent oxidation; no surface checking upon exposure to sunlight.

Suggested uses: Protective covering for underground low-voltage cable; connections for oil filled cables; insulation for submarine cables, ignition cables, drop cords, and wiring to combat corrosive fumes; transformer gaskets; high-voltage cable covering.

Lincoln Prize Winners Paid by Steel Checks

Steel checks were used to pay the winners of the first three prizes in the second Lincoln arc welding prize competition, sponsored by the Lincoln Electric Company, of Cleveland, Ohio.

The checks, for $7,500, $3,500, and $1,500, were



written on $\frac{1}{8}$-in. sheet steel. Each check is 24 by 10 inches. All writing, including signatures, was done by the arc welding process. Endorsement will be made by the winners by the same method, and at the bank of issue the checks will be canceled by sub-machine gun.

Winners of the steel checks are Lt. Com. Homer N. Wallin and Lt. Henry A. Schade, U.S.N., first; Maj. G. M. Barnes, U.S.A., second; and H. H. Tracy, Structural Engineer of the Southern California Edison Company, Ltd., Los Angeles, third. The winners of the 38 other prizes received checks written on paper.

Cutting Motor Maintenance Costs

J. S. Murray, Electrical Engineer
Follansbee Bros. Company, Follansbee, W. Va.

The easiest way to reduce maintenance costs and prolong the life of induction motors is to keep the windings and bearings clean, air gaps clear. Any motor construction providing, at reasonable cost, real protection against dirt and moisture will save many times its initial cost. Ball bearings with dust-type mountings and sealed-sleeve bearings have done much to reduce maintenance.

Within the past two years principles of ventilation of certain makes of totally inclosed, fan-cooled a.c. motors have been developed which make it possible to obtain the full open rating. In the design with which I am familiar the internal air is circulated by inside fans, transferring heat from the windings to the inclosing shields which seal the motor. Air blown across the outside surface of the inclosing shields absorbs the heat and carries it out through openings in the back bearing bracket.

The mounting dimensions of this type of totally inclosed, fan-cooled induction motor are the same as for standard, open-type induction motors of the same rating.

Our experience in operating this type of totally inclosed, fan-cooled induction motor in steel mills, where the atmospheric conditions are much the same as in foundries, cement mills, the mining industry, etc., makes us feel that the higher initial cost is entirely justified on maintenance cost alone, aside from the production loss usually involved in motor breakdowns.

Recently we dismantled four fan-cooled, totally inclosed motors that had been operating in a steel mill for eighteen months on extremely severe service involving 35 reversals a minute in a very dirty atmosphere and found that the windings were perfectly clean. Several other constant-speed applications made two years ago in dirty atmospheres have required no maintenance, except yearly renewal of the lubricant in the ball bearings.

On the other hand, we have numerous installations of open-type induction motors in locations where conditions are such that they have given entire satisfaction.

Some of the advantages which we know may be realized by the use of inclosed, fan-cooled motors are:

1. Protection of the windings against dirt and moisture, thus eliminating a very large percentage of maintenance cost and prolonging motor life.
2. Protection of the air gaps against clogging.
3. All the advantages of ball bearings or reliable sealed-sleeve bearings which are protected against dirt.
4. Motors are interchangeable in all mounting dimensions with standard open motors of the same rating.
5. Electrical and operating characteristics essentially the same as those of open motors.
6. Fire hazards are eliminated in locations such as chemical works, grain elevators, coal plants, etc.
7. Fully inclosed motors up to and including 30 hp. may be started across the line.

A Primer of Money

Because of the peculiarity of the times, discussions concerning money, credit, banking, bonds, loans, and a host of other financial and commercial terms are being forced upon all of us.

And for most of us the discussions are very mysterious, because we have forgotten or never knew the fundamentals of financial structures.

Fortunately the authors of "A Primer of Money" sensed our predicament, and now make available this excellent book explaining in an A-B-C way the principles that underlie monetary and banking systems.

"For the purpose of achieving utter simplicity, we have assumed the reader to be that highly improbable person who never before has read anything on the subject. Or, if he has, perchance in college, it was so long ago that he wants to brush up on the very fundamentals." In those words the authors define the objective which they actually have attained.

So here's an opportunity to learn a great deal about this money matter so troublesome today.

Authors: Donald B. Woodward, Financial Editor, and Marc A. Rose, Editor, *The Business Week*. Publisher: Whittlesey House Division McGraw-Hill Book Company, 330 W. 42d St., New York, N. Y. $2.

Alternating-Current Motor Repairing

In their latest book, "Rewinding and Connecting Alternating-Current Motors," D. H. Braymer and A. C. Roe present a wealth of the kind of practical shop information that is needed by everyone who is concerned with the rewinding or alteration of induction motors.

The data given cover in detail such topics as essential features of design and advantages of particular windings; constructing and checking a.c. winding diagrams; rules for modifying an existing winding

when making changes in speed, voltage, frequency, or number of phases; duplicating any existing standard or special lap or wave winding; laying out a new winding for any desired change in operating conditions; determination of the possible and practicable reconnections for any stator or rotor.

In addition to the topical discussions, tabulated data covering a wide range of windings are presented in a form for ready reference. In many cases this information will enable experienced men to supplement their notebooks and incomplete data from their own work.

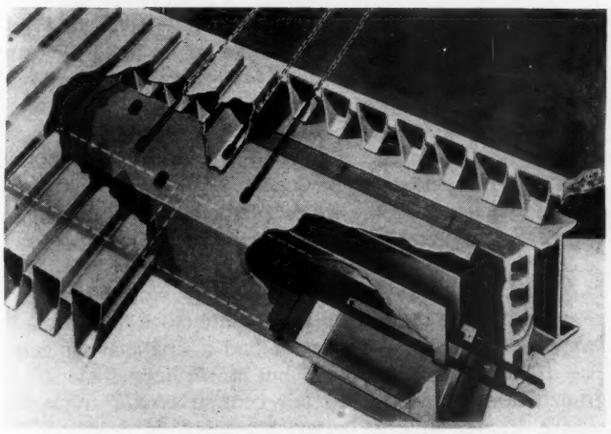
This book is published by the McGraw-Hill Book Company, Inc., 330 West 42d St., New York, N. Y. Price, $3.50.

■

Slab Steel Flooring

SOURCE, Mellon Institute

Development of a type of steel flooring has been announced by the Mellon Institute of Industrial Research, Pittsburgh, Pa. In its present form the flooring consists of slabs, 24 in. wide and up to 12 ft. 5 in. in length, that are fabricated by preforming two steel sheets and welding them together in the plane above the neutral axis. A



cross-section taken through the width of a completed unit shows four keystone-shaped cells, all connected together near the neutral axis. These four ducts, which constitute each unit, are spaced at 6-in. intervals and connect directly, when installed, with the corresponding ducts of the adjacent section of floor slab. This arrangement permits the use of the floor not only as a load-carrying member, but also as a multiple floor-duct system for all types of electrical lines.

Keystone slabs can be bolted, clipped, or welded into place across the structural members.

■

Electric Power Equipment

In the second edition of this volume by J. G. Tarboux several important changes and additions have been made. These comprise discussion of circuit-breaker contacts and mechanisms, including some new types; discussion of metal-clad switchgear; more thorough treatment of voltage regulators and voltage regulation of power stations; description of improvements in transformers; extensive discussion of economics of power generation.

The scope of this book is broad, starting with a brief survey of power resources, with a study of prime movers, and proceeding to a discussion of such topics as generating equipment; synchronous generator excitation; power plant circuit layouts; switching equipment; meters and measurements; calculation of short-circuit currents; transmission lines; relays; lightning arresters; substations and distribution systems.

Although written primarily as a textbook or reference for students this book contains a great deal of information that will be helpful to engineers engaged in practical work who wish to broaden their knowledge of some of the more common types of electrical power equipment.

It is published by the McGraw-Hill Book Company, 330 West 42nd St., New York, N. Y. Price, $5.

■

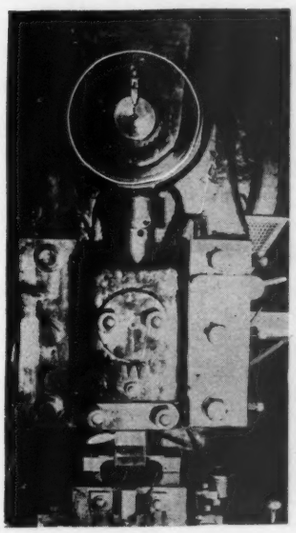
Indicator Shows Brake Adjustment

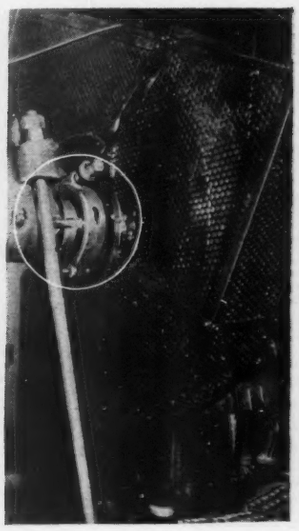
T. W. LAWSON, Foreman of Maintenance
Radio Condenser Company, Camden, N. J.

It is not difficult to arrange simple indicators to enable punch press operators and foremen to see at a glance the position of the crankshaft, and therefore to know of proper or improper brake adjustment. The indicators illustrated are cut from light-gage sheet metal; chisel marks are made on the shaft as witness lines.

Proper brake adjustment is extremely important. A brake adjusted too loosely can cause double or continuous tripping, faulty action of complicated dies, broken clutch pins, even the carrying away of the whole positive stop mechanism.

Too tight a brake can cause loss of power, excessive heating of bearings, scoring of shaft, excessive belt trouble, blown fuses, battered clutch pins, abnormal wear, and breaking.





A new question is presented herewith, and our readers' answers to previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

PLANT ENGINEERS' FORUM

QUESTION

What Excuse for Breakdowns?

Deserted by their wives in favor of the monthly bridge club, Frank Fulleger and George Shipman have had to find solace in each other's company at the local "talkie." The snappy comedy, however, has not served to cheer Frank, who has been suffering from the doldrums all evening. On the way home he relieves himself of some of his grievances:

* * *

"It may sound mighty fine in a success magazine, but in practice it's just so much horsefeathers!"

"What's the matter, Frank? Somebody step on your toes today?"

"Oh, it's the same old story—today was one of those days when everything just goes wrong. And then to top it all, the 'Old Man' in the Front Office has to pull a pound-the-desk act on me—"

"There, there, young man. Why all the excitement? Better start from the beginning and tell me all about it. Sometimes the Front Office remarks contain more truth than poetry, you know."

"Well, this was some poem. Our conveyor jammed right in the middle of the rush hour, the overload protection failed to operate, we burnt out the motor, and were tied up for four and a half hours. The production department raised hell and the big boss called me out Front—"

"And . . . ?"

"And, after I'd told him the whys and wherefores, he pounded his fist on the desk and shouted 'We don't take excuses here! We don't give them and we don't take them!'."

* * *

Of course we all can see the Front Office's point of view, even though we do sympathize with Frank. But what can be said about the dictum:

What excuse for breakdowns?

How Measure the Efficiency of the Maintenance Department?

(Question presented in the June issue)

FINANCIAL measurement of the maintenance department's expenditures is not sufficient to judge its efficiency. In order to save money, machines might be allowed to get out of order before repairing, and the loss to the company in spoiled work and upsetting of schedules would not be considered if only the money spent in maintenance were measured. Two measures must be used, financial and service performance.

The service factor must be considered equally as important as the financial. This can be done by comparison. From the records of previous years or months the number of hours of machine shutdowns because of repairs can be found. Set a certain percentage of hours as the maximum to be allowed for the department to run at 100 per cent efficiency. For each additional shutdown hour deduct a certain percentage, dependent upon the total machine hours in the plant.

By the method suggested machines will not be allowed to break down as frequently as they would if all the emphasis were on cutting the maintenance department's expenses. If the department had a financial efficiency of 100 per cent or over, but a service efficiency of much less, say 80 or 90 per cent, it would show that more money might better be spent in keeping the machines in condition, to avoid actual breakdown.

On the other hand, if the service efficiency proved to be 100 per cent or over but with financial efficiency under, it would mean that more money was being spent in maintenance than was profitable to the company.

The ratings and deductions for less than perfect performance require care in setting to be effective. They should be determined by past experience and expected improvement, and can be changed as conditions change.

BERNARD SHEREFF, *Engineer*
American Hard Rubber Company, Butler, N. J.

CONDITIONS in different industries vary so widely that what might be considered a good performance in one case would not be tolerated in another. Each maintenance engineer must analyze the conditions with which he is confronted and govern himself accordingly.

In industries using continuous processes where every

hour of delay means an irrevocable loss, the maintenance department must fortify itself with a stock of spare parts for any emergency. Each part of every machine and each unit of every process must be studied while the skies are clear so that each step in the job of replacement can be carefully thought out in advance and a definite method of procedure planned long before the emergency arises. By that method the maintenance department can build up a reputation for intelligent foresight and prompt performance.

In other industries, where production on standard articles is intermittent to maintain warehouse stocks, a week's delay to secure replacements is often more acceptable to the management than an investment in spare parts for which the need may never arise.

It is of course taken for granted that none of the breakdowns which the maintenance department is called upon to repair is of the preventable type. In processes where machines are operated intermittently, careful inspection at frequent intervals and preventive measures whenever necessary should be matters of routine. Where machines are operated 24 hours a day over long periods, the maintenance department must watch the operating unit closely and recommend a switch to the spare unit when there is any reason to suspect that the operating unit will not continue to function satisfactorily.

On certain classes of maintenance work other than breakdown repairs it is entirely possible to work on a budget allowance, and here the maintenance engineer must be careful that in his zeal to stay within his allowance he does not store up future trouble for others as well as for himself.

However, no matter how efficiently the maintenance department may be run, or how many sets of figures may be devised to show that efficiency, you can't get away from the fundamental fact that on the profit and loss statement maintenance is always a cost item and never a revenue item. Any maintenance engineer who feels neglected because he is left out of the spotlight should dig up his Kipling and read "The Sons of Martha" or, better yet, let him recall that old copy book maxim "Virtue is its own reward."

E. G. GREEN, *Plant Engineer*
Libbey-Owens-Ford Glass Company
Charleston, West Va.

MOST of us who are engaged in maintenance work have been searching for a long time for a yardstick by which our performance could be measured. So far as I am concerned, the search is still in progress, although I believe the efficiency of any maintenance department can be checked to some extent if certain records are maintained from year to year.

It must be kept in mind, however, that the real function of the maintenance department is to render service in time of trouble and that its activities cover a wide range of work sometimes hard to classify properly. Also in modern plants preventive maintenance is being practiced and it is usually hard to estimate the monetary value of this work, although most of us agree that it is necessary for economical plant operation.

The easiest way to show increased efficiency is to lower the total cost of maintenance yearly, assuming, of course, that the size of the plant and the standards for maintenance performance remain constant. A record should be kept of the number of jobs finished for comparison with the totals of other years and the cost of each job. Where work is of a routine nature, these costs can be compared with previous costs for similar work and where estimates have been made these costs can be compared with them, all of which should indicate whether or not the performance of the department is satisfactory.

Inasmuch as the time element is important in most maintenance work, a definite promise should be made as to the completion of each job at the time the order is received and a record kept as to the maintenance department's success in fulfilling these promises.

A certain amount of inspection work should be carried on each year and definite record made of the scope of this work to compare it with what was accomplished in previous years. A comparison of the list of major jobs for each year charged to capital account will, I think, complete the picture of the department's activities in a way that should indicate whether or not its efficiency is improving from year to year.

I realize that my proposals seem rather complicated in comparison with the simple manner in which sales and production department activities can be illustrated but, as stated in the first paragraph, I am still looking for a simple gage of maintenance department efficiency and trust the suggestions offered by others in your discussion may help me find it. C. W. SCHWABE

Superintendent Mechanical Department
Mallinckrodt Chemical Works, St. Louis, Mo.

What Human Qualities for Maintenance Men?

(Question presented in the May issue)

THE MAINTENANCE foreman should see that his men have human qualities, but he should have some himself before he tries to tell his men about them.

I happen to know about a plant other than my own in which a lathe operator burned out a fuse, used with temporary wiring, every time he ran the carriage to a certain position. The operator knew where the trouble lay but would not tell the chief electrician, whom no one in the plant liked. After several days, with many fuse replacements, a different electrical man showed up and was told promptly what was causing the shorts. This man had human qualities and was liked by the operators.

Because I am on good terms with the men they always tell me what happened to cause electrical trouble if they can. Even when called to jobs that don't belong to my department I treat them as if they did and get the cooperation of the men.

A good maintenance man should have self control, patience, and a sunny disposition. The most important of these is self control.

CHARLES R. DEANER, *Chief Electrician*
The Griswold Manufacturing Company, Erie, Pa.

COURTESY, tactfulness, sincerity, thoroughness, and loyalty in maintenance men are as important as their professional skill and knowledge.

Maintenance, as a department, acts under staff control, not under line control, as do the production departments. Maintenance is there to keep the pulse of the plant on the go; that means production equipment and all necessities in A-1 condition. Suggestions

from maintenance to production foreman, in relation to production equipment, go a longer way when made with courtesy and tactfulness.

Because maintenance men often are placed in key positions, sincerity and thoroughness are of great importance. If one can rely on a man and his work, a great deal of worry and trouble may be saved.

There are probably half a dozen ways in which certain jobs may be done, but there is only one right way—the method that costs the least and gives the best results. As such a decision is sometimes left to the man on the job, loyalty is demanded.

We all know of those rush calls. Instead of being a stubborn listener or having a few reasons at hand showing why it cannot be done in this certain and explained way, courteous and tactful assistance will be repaid.

The maintenance department, engineer, foreman, and men are working for uninterrupted production. On their shoulders that responsibility is placed. It should be understood that good will should emanate from this department. C. B. SCHAFER, *Research Department Libbey-Owens-Ford Glass Company, Toledo, Ohio*

Regular Foremen's Meetings?

(Question presented in the April issue)

EXPERIENCE with regular foremen's meetings has convinced me of their worth. They should be conducted by management on company time. Subjects should be presented by management. A complete system of records is essential as a basis for discussion. Not longer than two weeks should elapse between meetings.

According to my experience (gained at a smelter in Spain) the foremen get a wider grasp of the whole system of production. They learn to appreciate the difficulties of other departments. They help, and receive help from, other foremen. I have noticed that sometimes a rank outsider (from the technical point of view) will give a most valuable suggestion. The discussion of difficulties and overcoming them by combined effort engenders a spirit of co-operation which is of all-around usefulness. On the management side there will be the throwing overboard of that policy of secrecy which is so often a brake on foremen's activities. E. SCOTT RIVETT, *Plant Operator Noranda Mines, Ltd., Quebec, Can.*

OUR COMPANY has long fostered the idea of educating its executive personnel through the medium of foremen's meetings. This experience indicates that few problems concern only a single individual, and that each problem should be made known and solved in a meeting of all foremen.

We do not consider that a foreman who is baffled by a complex problem is incompetent. When the source of a foreman's trouble arises from conditions with which he is not familiar, it frequently happens that the foreman of another department can help him out. We have found that even experts' opinions can be supplemented profitably by suggestions from other department heads. When the maintenance department learns the problems of manufacturing it will be in a better position to serve and offer ideas and constructive criticisms.

Every inducement should be offered to encourage the men to state their views and opinions. An informal atmosphere goes a long way toward easing the mind and dispelling the embarrassment that often accompanies public speaking.

But, after the men have entered into the spirit of the meetings, the anticipated results are achieved and the fullest benefits are derived by both the foreman and the company.

CARL R. METZGER, *Foreman Maintenance Department Franklin Pottery, Lansdale, Pa.*

ONCE a month in our plant a foremen's meeting is held in the evening on the employees' time. The management feels that every foreman should be willing to give one evening of his time for the interest of the company which enables him to make a living.

Business conditions are discussed. Examples of faulty manufacturing are brought up and methods of correction discussed. When such trouble is traced to faulty equipment, maintenance becomes the topic under discussion.

When the meetings were first started the plant superintendent did most of the talking. At the suggestion of one of the foremen, half of the time now is turned over to the foremen, who talk on subjects pertaining to their departments.

The study and effort necessary to prepare and deliver these talks make better foremen, developing their self-confidence and increasing their knowledge of their work. J. CONRAD WATSON, *Master Mechanic Franklin Pottery, Lansdale, Pa*

TIME spent in well-conducted foremen's meetings is a good investment. An interchange of ideas among the heads of different departments is helpful in many ways. In most cases a man who has advanced to the position of foreman is one of experience and keen perception and, therefore, he will have valuable ideas regarding departments other than his own.

It is often the case that department foremen, in their eagerness to make a showing, will operate in such a manner as to be detrimental to other departments. For example, in his efforts to economize the maintenance foreman might try to work with too few men. As a consequence, breakdowns would be excessive and repairs take valuable time, and production in other departments would suffer.

Because all departments are interdependent regular meetings of the foremen promote coordination and team work among them. Foremen who would not care to run to the master mechanic or superintendent with problems that involve other departments will discuss them freely in a meeting of this kind.

The meetings should be conducted by the master mechanic or some similar official. However, this official should not attempt to dominate the meetings; the foremen should feel free to express themselves fully.

There are two reasons why a higher official should conduct the meetings. One is that an arbitrator is needed occasionally to settle a point of contention, and the other and greater reason is that the foremen will naturally strive harder in the presence of their superior.

W. L. COTTON, *Electrical Department Rock Island Lines, Dalhart, Tex.*

QUESTIONS and ANSWERS

Conducted by
G. A. VAN BRUNT
Associate Editor

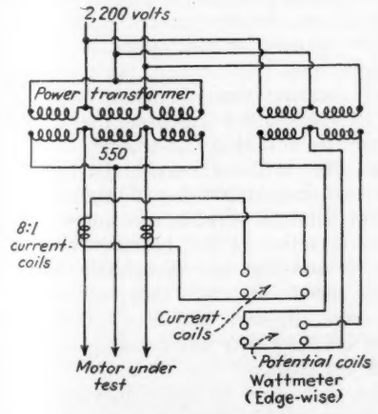
Must Tight Side of Belt Be on Bottom?

I have always understood that the slack side of a belt drive should be on top. In the case of some drives that are being rearranged it will be very difficult or impossible to have the tight side on the bottom, and I am wondering whether there will be any loss of efficiency or capacity if we operate them with the slack side on the bottom. These drives transmit from 3 to 15 hp. The distance between shafts is normal. Will the material from which the belt is made—leather, rubber, fabric—make any difference? B.G.A.

Chicago, Ill.

What Is Wrong with These Connections?

In order to check our 550-volt motors with a wattmeter a spare G.E. indicating wattmeter was removed from the switchboard. This meter had a full-scale reading of 1,500 kw., and it was decided to replace the 80: 1 current transformers with others of 8: 1 ratio, thus bringing the scale down to 150 kw. Potential coils suitable for use on the 550-volt circuit were not available;



so as an experiment the meter was connected as shown in the diagram, using the 2,300-volt coils. The readings were very unsatisfactory, which I believe was due to the potential transformer being connected to the primary side of the transformer bank. Do other readers agree with me on this point? R.G.M.

Prince Rupert, B. C., Canada.

Please submit answers promptly. We expect to publish no answers later than the second issue after the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used

■

Why Is Oil Injurious to Motor Windings?

It is frequently stated that oil is very injurious to motor windings. Why should this be true in view of the fact that transformer and other types of coils will give years of service when permanently immersed in oil? Are transformer coils treated with a different kind of varnish than is used on motor windings? Or are lubricating and insulating oils so different in character that one will attack insulating varnish, whereas the other will not? G.F.K.

Grand Rapids, Mich.

LUBRICATING oils that do not contain current-conducting ingredients will not damage motor windings at first. But they should be cleaned off immediately because they will cause deterioration of the insulation if the winding is allowed to become oil-soaked. Damage done by lubricating oils in most instances is due to moisture and foreign materials such as dirt, filings, etc., which the oil picks up and carries into the windings. These foreign materials form conducting paths between phase groups or coils in the same phase group, resulting eventually in a damaged winding. Lubricating oils containing graphite are good conductors and will cause damage if allowed to penetrate motor windings.

Another fact that should not be overlooked is that a winding which is oil-soaked may be ignited by a spark or open flame and the entire winding destroyed before the blaze can be extinguished.

The oils used in transformers, circuit breakers, and so on are manufactured especially for that purpose. This oil performs two important functions: It insulates the coils from each other and from the core, and conducts heat from the coils and core to the surface of the tank. It is free from conducting material, is sufficiently thin to circulate rapidly when subjected to changes in temperature, and is not ignitable until the temperature reaches a high value. For this purpose mineral oil is used almost exclusively. Oils used in transformers and other devices should not contain moisture, alkali, acids, or sulphur compounds.

Even these oils will not function properly unless they are kept free from moisture and foreign materials. Therefore, the equipment must be inspected regularly and the oil tested to be absolutely sure that it is in good condition.

HAROLD FLOWER.

Electrician
The Cambria Clay Products Company
Blackfork, Ohio

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Preventing Rise in Voltage on Power Lines

Our lighting circuits are fed from the 220-volt, three-phase power lines. At times just as we cut off the power from our motors the voltage will jump to 260 or 270; hence, we are forced to use 135-volt lamps in order to avoid frequent burnouts. Does this excessive rise in voltage indicate any defects in the power company's equipment, or does the fault lie in our plant? W. L.

Springfield, Mo.

IT APPEARS to me that the voltage of the lines which supply electrical energy to this plant is controlled by a feeder regulator and that the regulator cannot act quickly enough to prevent a short period of high voltage, when the heavy load is suddenly taken off the line. The obvious remedy is to arrange to have the motors stopped one at a time.

At one time we had a large motor

that made frequent starts and stops, with consequent disturbance of voltage conditions. I suggested cutting out the regulator and the power company found that the service was much improving by so doing. F. W. REED.

Chief Electrician
Northern Pacific Railway
St. Paul, Minn.

TESTS should be made with a voltmeter or, preferably, two voltmeters of the indicating or curve-drawing (graphic) type. If these are used a permanent record for any period of the day can be obtained. One instrument should be located where the power company's lines come in and the other at the approximate load center where the voltage variations have been recorded or lamps burned out.

The difference in the readings of these meters at the same instant will show what the voltage drop is on the plant lines. The variations, if any, in the readings of the meter at the supply point will indicate the drop or regulation of the power company's lines. In its contract the power company usually gives the limits of, or voltage regulation of, the supply circuit and this figure can be checked from the variation in the readings of the meter at the supply point. The questioner does not state what the minimum or lowest value of the voltage is at the motors or lights under load conditions, but it appears that with top voltages of 260 to 270 the minimum may be higher than 220 volts. Should this be the case the power company may be able to change voltage taps on the transformer bank supplying this load and thus improve conditions.

If the supply voltage is reasonably steady and the difference between voltage readings taken at the supply point on the premises and the load center be more than 10 per cent, or, say, 25 volts, the plant wiring should be changed to meet this condition. Based on the information given the variation of 50 volts, assuming 220 volts at the motors referred to, is excessive. A voltage regulator might be used but it would be expensive and is neither desirable nor necessary.

C. O. VON DANNENBERG.

Altoona, Pa.

■

Lubrication of Ball and Roller Bearings

Lubrication of 60 motors and generators fitted with ball or roller bearings is giving us trouble. These machines are rated from 1- to 250-hp. and are used on equipment ranging from gasoline-electric locomotives to small sump pumps. Careful reading of manufacturers' bulletins has failed to give me the answer to these questions: (1) How much lubricant should be kept in a ball bearing? (2) What kind of lubricant should be used? (3) How can I tell when the proper amount of lubricant is being used? We use light grease and in order to prevent it from creeping out along the shaft a small hole has been drilled in each bearing level with the bottom of the shaft. In spite of this precaution a great deal of trouble is caused by grease getting on the commutator and windings. How can I demonstrate to the oilers and operators when enough grease, but not too much, has been put in? J.R.C.

Peoria, Ill.

WHEN an anti-friction bearing motor or generator is ready for service remove the bearing covers and see that the housings are about two-thirds full of good grease. If it is packed in tightly remove some. Replace the caps. Remove grease cups or pressure fittings and replace with plugs, so that it will be impossible for anyone to give the bearing a "shot" of grease. Use a good grade of high-melting-point grease having a density equal to about No. 2.

If a bearing starts to heat, never apply more grease without removing the cap to see whether a small amount cannot be removed, rather than more added. *More bearings heat because there is an excess of grease than because there is not enough.* Have a few authorized maintenance men attend to all greasing and keep an accurate record of when it is done.

Local conditions govern how often new grease should be applied. In a stone crushing plant, where severe dust conditions are encountered, it should be done every two or three months. In cleaner places bearings will run six months without any lubrication attention whatever. When new grease is to be applied remove the bearing housing caps, thoroughly clean the bearing and housing, squirt in a little light motor oil and apply new grease. Wherever possible apply the grease in this manner; never use the pressure method to fill bearings if the grease can be put in by hand when the caps are off.

We have a total of 11,000 hp. in anti-friction bearing motors and generators, ranging in size from 1 hp. to 200 hp., all operating in very dusty places. A systematic method of greasing is used and accurate records are kept. New grease is applied every 60 or 90 days.

During the past year we have had to replace only two bearings: one on a 7½-kw. exciter generator and one on a 20-hp. motor. We have had no lost time due to motor or bearing trouble where anti-friction bearings are used.

This record should be sufficient to show that practically all trouble can be eliminated with anti-friction bearings if they are properly lubricated.

Electrical Engineer L. F. MILLER.
New York Trap Rock Corporation
Haverstraw, N. Y.

CONDITIONS inside the ball bearing housing must be considered in selecting a lubricant. The balls and their retainers travel in the direction of shaft rotation at roughly one-half the speed of the shaft. This sets up the same kind of disturbance in a soft grease or oil that an egg-beater would. Greases that are not so stiff as to churn, but stiff enough to cling to the balls and retainers are, therefore, necessary for satisfactory service.

One large motor manufacturer uses as a standard lubricant a soda soap compounded with a heavy, cylinder-stock oil. This grease is so stiff that it is difficult to use it in a pressure gun. Another manufacturer uses a combination soda-and-lime-soap grease soft enough to flow readily from a pressure gun, but which does not tend to churn in the bearing.

A straight lime-soap grease tends to aerate and increase in volume under ball bearing service. Others separate out and the oil promptly leaves the housings; or if the housings are oil tight, it churns and generates heat. Naturally, the user then adds more lubricant, which is the wrong thing to do.

One grease manufacturer supplies his product in tubes that hold from 4 oz. up. The threaded end of these tubes fits a ⅛-in. pipe thread and so can be screwed directly into the housing and the grease squeezed in without the aid of a gun.

How much lubricant should be used cannot be foretold exactly without familiarity with the motor design. A little experimenting, however, should settle this question. One 50-hp. motor might have an open space around the bearing that would hold a pound; another, only a few ounces. If the housing covers are removable I suggest that the closed end be opened and the lower half loosely filled to the bottom of the shaft with a grease that is just soft enough to settle, but not flow. In most cases this amount will be correct for the pulley or shaft extension end.

Ball bearing manufacturers will be glad to supply a list of greases that come nearest to fulfilling all-around conditions. They will not freeze at 10 deg. F. below, or melt at 200 deg. F. above and do not change consistency under the churning action of ball bearing service. Even if housings are completely filled, unless speeds are high they will work out only slightly, and can easily be wiped off since they will not drip or flow along the shaft.

The best time to apply lubricant is while the units are running, because at least one-third of any grease will work out of a filled housing if it is applied while the unit is idle. This is because of an increase in volume in some cases, and the need of running space for balls and retainers in all cases. D. M. DAVIDSON.

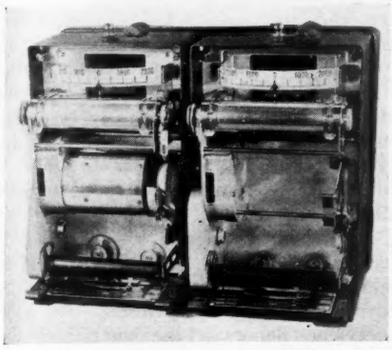
The Fafnir Bearing Company
New Britain, Conn.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs

Esterline-Angus Graphic Instruments

An entire new line comprising 22 different kinds of recording instruments—a.c. and d.c. ammeters, wattmeters, and voltmeters, and recorders for speed, vac-



uum, high and low pressure, frequency, power factor, time and production, motion and position, and water level—have been announced by The Esterline-Angus Company, Indianapolis, Ind. They are available in portable, switchboard-flush, switchboard-front, and wall-type cases. All except the portable type are made in double or twin designs, consisting of two recorders in one case.

The measuring elements are all of new design, and embody such features as insulation which withstands a 5,000-volt test; an inkwell that greatly reduces ink evaporation; inkwells and pens removable without the use of tools; magnetic damping; interchangeability of all measuring elements in the different instrument cases.

The spring clocks which drive the charts are made in removable units—escapement, spring barrel, and gear train. These units can be replaced in the field, without putting the instrument out of service.

The three springs in the clock are wound at one time from the front of the meter by means of a crank, permitting close mounting of instruments on a switchboard.

All instruments are arranged so that the chart rolls can be coupled together, accurately synchronizing them. The coupling is placed back of the gears which fix the chart speed, so that instruments operating at different speeds can be connected.

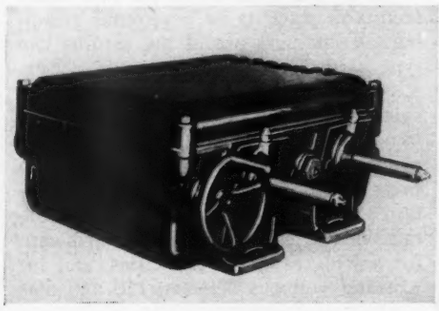
Electrical synchronous motor clocks can be furnished for driving the charts. Both these and the spring clocks give chart speeds ranging from $\frac{3}{4}$ in. an hour to 12 in. a minute.

Also available is an instrument for recording quantities that change rapidly. The meter operates at a slow chart speed when the values measured are steady, but when there are rapid changes, the chart automatically speeds up to 3,600 times the slow speed and gives a "slow-motion-film" record of the changes. When conditions become normal slow speed is resumed.

■

Lewellen Variable Speed Transmission

The Lewellen Manufacturing Company, Columbus, Ind., announces its smallest size variable-speed, fully inclosed transmission, the size 105. The unit is designed for use with a $\frac{1}{4}$- or $\frac{1}{3}$-hp. motor, with a maximum speed ratio of 6 to 1. It is adapted especially for use in the drives of small production machines requiring accurate variable speed

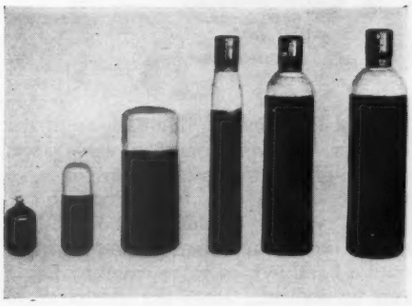


control. It may be lubricated and adjusted without removing the cover or stopping operation.

■

Linde Gas Cylinders

The Linde Air Products Company, 30 East 42d St., New York, N. Y., has announced a line of cylinders for the transportation of refrigerant gases such as



sulphur dioxide, methyl chloride, ethyl chloride, isobutane, butane, and propane.

A variety of standard cylinders is offered. Special designs are available. The capacities of the small portable type are $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{8}$, 1, $1\frac{1}{4}$, $2\frac{1}{2}$, 3 and $3\frac{1}{2}$ gal. Larger transportation cylinders can be supplied in capacities up to 26 gal. Storage tanks for refrigerant gases of mechanical refrigerators also are manufactured.

■

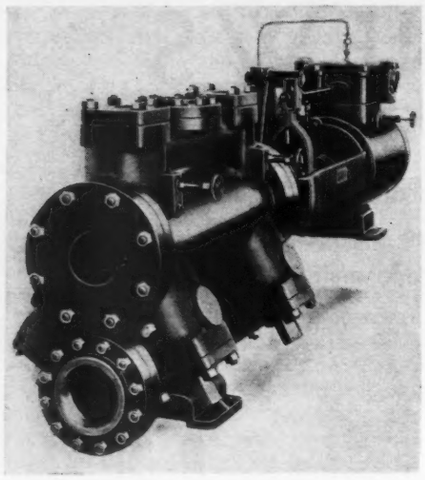
Austin Company Announces Welding Division

Establishment of a welding division has been announced by The Austin Company, Cleveland, Ohio. The division is equipped to make and render engineering service on a wide variety of weldings, such as frames, bases, and parts.

■

Worthington "Hivol" Pumps

To meet the demand for close-clearance pumps to handle "wild" fractions—casing-head gasolines, butanes, propanes, and other volatile liquids—the Worthington Pump and Machinery Corporation, Harrison, N. J., has introduced a line of direct-acting steam pumps, known as "Hivol." The pumps have clearances of between 12 and 17 per cent, depending on their size and stroke. Suction and discharge valves are located at the extreme end of the liquid cylinder—the suction valves below, and the discharge valve above the piston on the vertical centerline of the cylinder. This design is reported to permit



straight-line flow of liquid through the cylinder, maximum suction valve area, and minimum volumetric clearance. To remove any gas which may accumulate in the cylinder as the result of failure of the liquid supply each pump is fitted with a hand bypass valve whereby liquid can be admitted from the discharge to the suction side of the pump and full-flow conditions established. The liquid cylinder is designed for 400-lb. per sq.in. working pressure on both the suction and discharge sides. The liquid cylinder liner is of the full-length, removable type.

■

American Cable Licenses Wickwire Spencer

The American Cable Company, 230 Park Ave., New York, N. Y., announces that the Wickwire Spencer Steel Corporation, 41 East 42d St., New York, N. Y., has been licensed to manufacture preformed wire rope under the American Cable Company's patents.

■

Fairfield Portable Troughed Belt Conveyor

A portable, troughed-belt conveyor, built in lengths of 20, 25, and 30 ft. and primarily intended for handling sand, gravel, crushed stone, small sizes of coal and other abrasive materials has been announced by The Fairfield Engineering Company, Marion, Ohio. It is mounted on 48-in. roller-bearing carriage wheels.

The conveyor belt is rubber, 18 in. wide and runs over Fairfield ball-bearing idlers. A steel-plate receiving hopper at the foot end centers the load on the conveyor belt. The receiving hopper plates are fitted with replaceable rubber wear strips. The conveyor is equipped for its full length with steel skirt plates, which provide a carrying trough 6 in. deep.

Conveyor discharge height is adjusted by a machined worm winch of the self-locking type, mounted on the side of the frame.

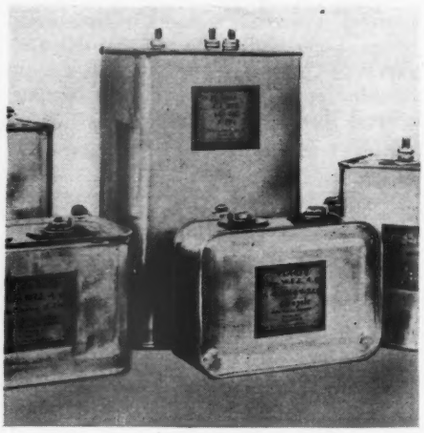
Power is furnished by a 3-hp., ball-bearing electric motor or a 4½-hp. air-cooled gasoline engine, and is transmitted from the motor to the headshaft through steel roller chains. The main drive chain is fitted with idler sprockets and automatic-tension, spring take-up.

Pressure lubrication fittings are provided for all bearings.

■

Dubilier Oil-Filled Condensers

Oil-filled condenser units of standardized design that permit any desired capacity to be obtained from a single unit or a combination of units have been developed by the Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York, N. Y. The cans are of uniform width and depth, varying only in height. The common width and depth facilitates stacking or horizontal grouping. Containers are of the sardine can type with double-rolled seams. Terminals can be brought out through one side or through the top of each container, as desired. The capacitator proper or section is of the semi-compressed design. Paraffin oil that contains no acid is used. Units are obtainable in a number of standard cans for a wide range of capacities, and for working voltages between 110 and 660.



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Pyroil Liquefied Graphite

Development of Pyroil, a liquefied graphite motor lubricant claimed to resist successfully any degree of heat or cold or the washing effects of raw gas, has been announced by The Pyroil Company, LaCrosse, Wis. It is a concentrated extract to be added to regular lubricating oil. The chief ingredient is a liquefied colloidal graphite, manufactured in an electric arc furnace at a temperature of 7,500 F. The high temperature is applied so that impurities such as iron or silica will pass off as gases, leaving the center core practically pure graphite.

■

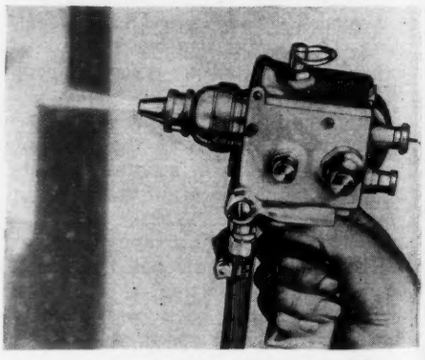
Metallizing Company "Metallizer" Spray Gun

For spraying metal coatings on a wide variety of materials to resist corrosion a spray gun, named the "Metallizer," has been announced by the Metallizing Company of Los Angeles, Ltd., 1218 Long Beach Ave., Los Angeles, Calif. Some of the surfaces that can be coated to any desired thickness are wood, plaster, concrete, paper, cloth, glass, and metal. Among the metals that can be sprayed by the gun are lead, tin, zinc, brass, nickel, silver, and aluminum.

Speed of application depends principally on the melting point of the metals used. In a laboratory test, flat surfaces were coated with lead at the rate of over 180 sq.ft. per hr., and a tin coating was made at a speed at over 290 sq.ft. per hour.

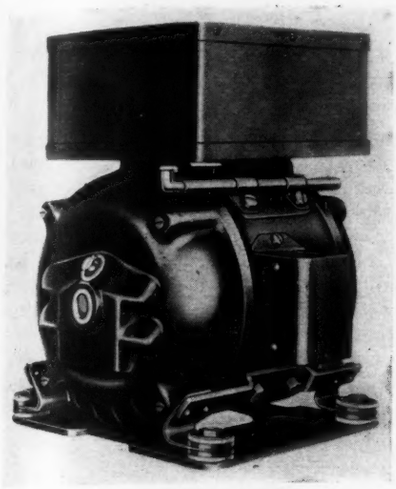
The required metal in wire form is fed from the spool into the gun and is pulled through automatically at the correct speed by cog wheels. An oxy-acetylene flame in the nozzle of the gun melts the wire and an extremely high air pressure breaks the molten metal into atoms and sprays the hot particles through the air. Because the heat on impact is negligible paper or fabrics may be coated without injury. To operate the gun sand blasting equipment for roughening metal and glass surfaces; an air compressor that will deliver 25 cu.ft. per min. at a pressure of 70 lb. per sq.in.; and standard gage wire of the required metal are the auxiliary equipment and supplies required.

Three lengths of hose, for connection to the oxygen tank and the acetylene or hydrogen tank, two regulators for connection to oxygen and gas tanks, wire nozzles and air caps for the different size wires, a lighter and a technical data manual are furnished with each gun.



Century Capacitor Motors

Single-phase capacitor motors, from $\frac{1}{8}$ to 10 hp. in size, have been announced by the Century Electric Company, St. Louis, Mo. They are furnished for



single- or multi-speed operation with normal torque, high torque, or low torque characteristics. Each of the small sizes has the capacitor box mounted on the top of the motor, and boxes are furnished separately for wall mounting in the larger sizes. Operating characteristics of the motors give them a wide range of applications, from the direct-connected fan to the more exacting service required for oil burners and refrigerators.

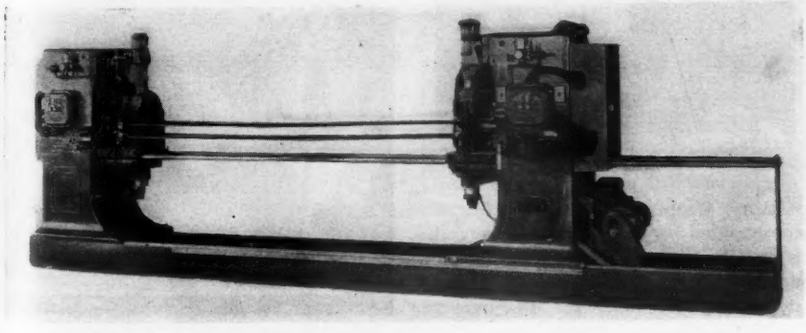
■

Thomson-Gibb Electric Soldering Heater

A special application of direct controlled heating by the electric resistance method is announced by the Thomson-Gibb Electric Welding Company, Bay City, Mich. It was developed for the rapid soldering of from three to twelve copper tubes on which are assembled a large number of flanged fins, each of which must be thoroughly soldered to each tube for good thermal contact.

One machine is fixed on a base, and the other is adjustable along the base through a distance of 10 ft. by means of a motor-driven worm reduction unit, spur gears, and rack. Adjustable time relays are provided to give definite time of heating work. Clamping of the work is accomplished by means of air cylinders, and clamping jaws are adjustable. Each machine of the duplex unit carries its own transformer. One side of each secondary is connected to heavy bus bars, and the work being heated forms the other side of the secondaries.

This method of controlled heating by electrical resistance has other applications to similar classes of work such as heating for annealing, heat treating, and heating for forging and bending.



■

Divine "TonWate" Swivel Caster

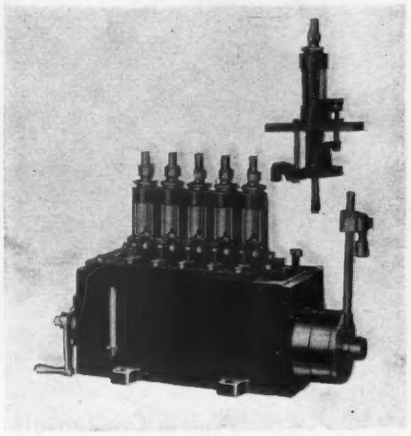
In place of the king-bolt, a flexible ball joint is incorporated in the "TonWate" truck caster, announced by the Divine Bros. Company, Utica, N. Y. Main load bearing and swivel bearings operate in a continuous reservoir of lubricant, sealed against dirt and water. Hub guards tend to keep out dirt, grit, and water, and prevent strings and

raveling from winding around the axle and binding the wheel. Steel or canvas-cushioned wheels are available.

■

Bowser Force Feed Lubricator

A force feed lubricator, known as Figure 451, is announced by S. F. Bowser and Company, Inc., Fort Wayne, Ind. It is equipped with liquid-filled sight glasses. A single plunger serves the dual purpose of drawing the oil from the reservoir and forcing it in a straight vertical path through the



sight glass to the point of lubrication at the end of the feed line. Each pumping unit may be individually removed and adjusted while the lubricator is in operation. A standard fitting permits injection of the liquid for refilling by means of a grease gun.

■

Farval Corporation Formed

Announcement is made of the formation of the Farval Corporation, 3277 East 80th St., Cleveland, Ohio. The new corporation has acquired the manufacturing and sales rights for the centralized system of lubrication formerly manufactured by Lubrication Devices, Inc., Battle Creek, Michigan.

■

Techno Spray Oiler

Techno Products Company, 7523 Santa Fe Ave., Huntington Park, Calif., announces a pressure oiler with positive flow control obtained by means of an active trigger. Nozzles are interchangeable. Construction is of cast

aluminum, with brass fittings for high pressure. Air from a hand pump, spare tire, or other pressure outlet may be utilized. A variety of attachments widens the range of uses.

Austin Convertible Shovel and Crane

Austin Manufacturing Company, 400 North Michigan Ave., Chicago, Ill., announces the "Badger" $\frac{3}{8}$-yd. convertible tractor shovel. It can be converted from a standard excavating unit with a dipper and dipper boom into a crane with a clam shell attachment or with a telescopic boom and a sheave block hook. Thus the tractor can be used not only for excavating but also for unloading and loading bulk materials and for general materials handling work.

■ ■

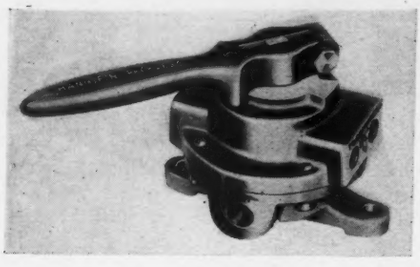
Ohmite Metal-Impregnated Rheostat Contacts

Metal - impregnated, carbon - graphite rheostat contacts have been announced by the Ohmite Manufacturing Company, 636 North Albany Ave., Chicago, Ill. Each button is kept in place by a hardened steel spring acting through a universal joint. This construction is provided to compensate for minute undulations. The steel spring carries no current because the contact is connected to the rotating arm by a flexible brass strip.

■

Hannifin "Packless" Duplex Valve

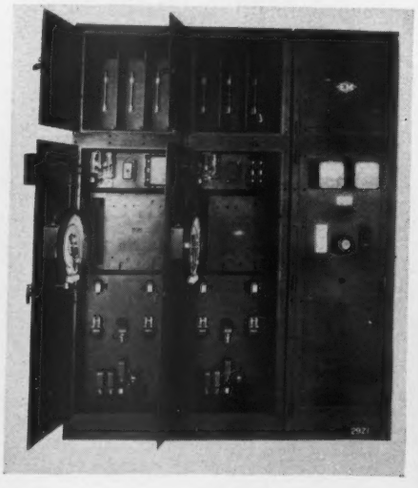
Hannifin Manufacturing Company, 621 South Kolmar Ave., Chicago, Ill., announces the "Packless" duplex air control valve, designed for use on machines that employ two air cylinders which operate in progressive sequence. The valve has four independent outlet ports for control of two double-acting cylinders. It is designed so that two cylinders can be operated in either direction and in any sequence desired. The unit is furnished in two sizes—Model D-37, with $\frac{3}{8}$-in. intermediate pressure connections, and Model D-75, with $\frac{3}{4}$-in. intermediate pressure connections.



■

Electric Machinery Starter

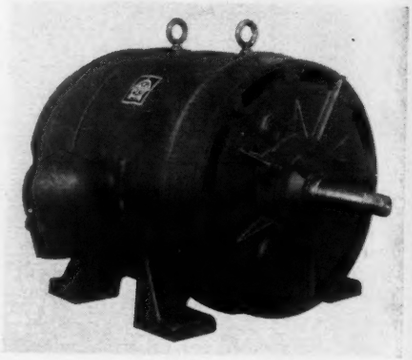
Cubicle automatic starters for synchronous motors have been developed by the Electric Machinery Manufacturing Company, Minneapolis, Minn. They are recommended for installations where the starter is to be placed out in the mill room with the motor. Each starter has a front compartment for the meters, control relays, rheostat, and field contactor, a rear compartment for the oil-break line switches, and an upper compartment for the disconnects. The starter is designed to permit access to all working parts.



■

Reliance A.C. Motors

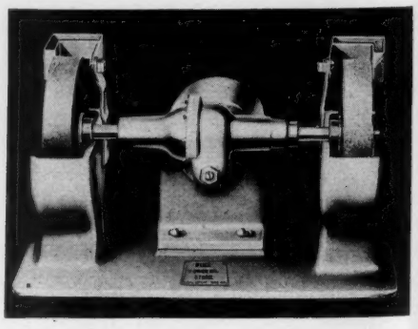
For driving automatic roller and catcher tables in sheet and tin plate mills, a.c. motors have been developed by the Reliance Electric & Engineering Company, Cleveland, Ohio. The motors are designed with torque characteristics to give rapid reversals. They may be built to reverse 40 times per min. Low-inertia rotors are provided to keep reversing losses at a minimum. Asbestos windings are provided for safety. Ball bearings are used with cartridge-type mountings. The motors may be built so that they are interchangeable for table-tilt and conveyor applications. They are furnished in all sizes required for mills used for rolling sheets and tin plates automatically.



■

Pike Power Oilstone

Pike Manufacturing Company, Pike, N. H., announces the power oilstone No. 60. It is designed to put an oilstone finish on cutting tools that cannot be oilstoned on a regular bench stone. Each unit includes one coarse and one fine India oilstone, two gravity oil feeds, a universal motor, an 8-ft. extension cord with plug, and one can of oil.



Westinghouse Watthour Meter

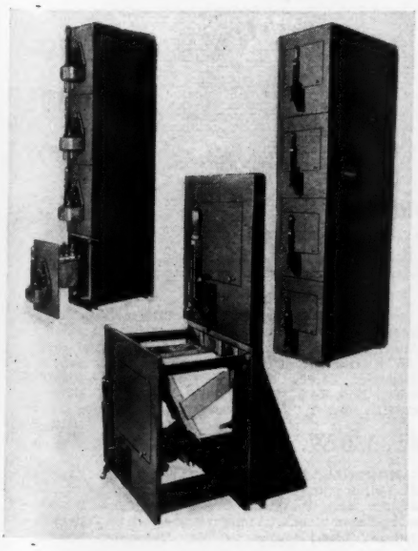
Type OC single-phase watthour meter has been developed by the Westinghouse Electric & Manufacturing Company, Newark, N. J. The electromagnet has

been enlarged over previous models to provide for more thermal capacity in the current coil, and the range of the meter has been extended so that only three current ratings (5-, 15-, and 50-amp.) are required for self-contained loads. The 5-amp. meter starts on approximately 1 watt, and the 15-amp. model on approximately 3 watts. All OC single-phase meters have the same size base and terminals; and all parts except the nameplate, electromagnet, and register are identical and interchangeable in all ratings.

■

Roller-Smith Switchboards and Cubicles

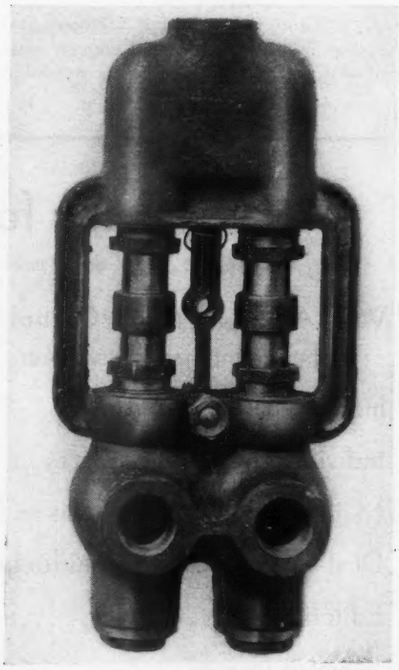
Sectional-steel, dead-front switchboards and cubicles are offered by the Roller-Smith Company, 233 Broadway, New York, N. Y. The switchboard may be made up of air circuit breakers, oil circuit breakers, indicating and recording instruments, dead-front switches, or a combination of all four. Installations are built up of units, each unit containing one breaker. Placed one above the other, the units form a stack; and stacks are placed side by side to form a section or a complete switchboard. Each unit consists of a frame and a removable breaker carriage. The breaker carriage is slid into position from the front of the board, and when it is removed, the breaker may be operated and adjusted.



■

Specialty Machine Valves

Specialty Machine Works, 495 East Taylor St., Portland, Ore., announces the development of a line of valves of the quick-acting type. They can be packed under pressure and will take the place of plug valves. They are designed for such applications as air hoists,



quick-acting cylinders, shot-gun feeds, and friction drives. These valves are adapted easily to electrical control and can be operated mechanically at great distances with accuracy. They vary in size from $\frac{3}{8}$ to 3 in., and are used for air, oil, gas, and steam.

■

Linde "Oxweld" Regulators

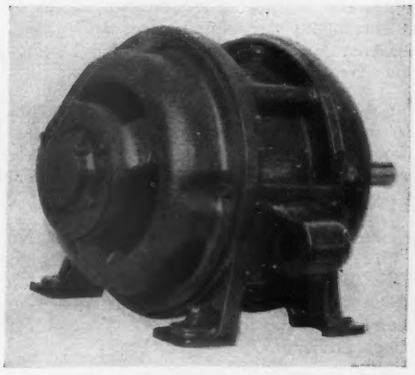
Two light duty "Oxweld" Regulators, which may be used with the Type W-15 welding blowpipe, have been introduced by The Linde Air Products Company, 30 East 42d St., New York, N. Y. They are designated as the Type R-48 oxygen

regulator and the Type R-49 acetylene regulator. Bonnets of both types are held in place by a forged brass cap ring to assure a non-leaking diaphragm. Assembly and disassembly are facilitated by a ribbed cap ring. The monel metal stem is similar to that used in other regulators of the line. The diaphragm is made of rubber composition, and the springs are of cadmium-plated steel. Pressure forgings are used in the body cap ring and pressure adjusting screw.

■

General Electric Screenless Motor

A screenless open motor, designed to meet conditions such as are encountered in the textile industry where the atmosphere is heavily laden with floating particles of lint, has been announced by the General Electric Company, Schenectady, N. Y. Air passages have been constructed so that, as soon as lint enters the motor, it is blown out. No attempt has been made to prevent lint from entering the motor. This design has been made possible by the following construction features; smooth glossy windings to which lint will not adhere; no pockets or recesses in or about the windings; large frame and



shield openings which allow lint to pass freely in and out; and dust- and oil-tight bearing housings which eliminate lint-catching spots of oil or grease.

TRADE LITERATURE

For copies, address the manufacturers concerned

■

(195) PUMPS—Catalog, commercial, industrial, domestic, municipal and special pump applications.—Westco Pump Corporation, Davenport, Iowa.

(196) METER—Circular 1938, type OC watthour meter in 5-, 15-, and 50-amp. sizes.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(197) POWER FACTOR CORRECTION—Form No. 3126, 20 pages, "Permittors for Power Factor Correction."—Products Protection Corporation, affiliated with the Safety Car Heating and Lighting Company, 75 West St., New York, N. Y.

(198) WATER METERS — Bulletin W-900-B9, 8 pages, disk type meters from ⅝- to 2-in. sizes.—Worthington Pump and Machinery Corporation, Harrison, N. J.

(199) REGULATORS—Bulletin 1100-A, 8 pages, pressure and liquid-level regulators for automatic control of air, gases and liquids.—The Electric Controller & Manufacturing Company, Cleveland, Ohio.

(200) AIR SEPARATORS—Catalog A, 16 pages, Swendeman automatic separators and receiver drains for the elimination of oil and water from compressed air lines, principles of operation and applications.—The Leavitt Machine Company, Orange, Mass.

(201) LIGHTNING ARRESTERS — Booklets Nos. 3 and 4 of a series, 8 pages each, crystal valve lightning arresters.—Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa.

(202) VENTILATING FANS—Bulletin F-5, 8 pages, data on capacities, dimensions and prices of safety ventilating fans, single-, two-, and three-phase, a.c. and d.c.; high speed fans for industrial use; and fans for pulley drive.—L. J. Wing Manufacturing Company, 154 W. 14th St., New York, N. Y.

(203) WIRES AND CABLES—Bulletin, 24 pages, changes in the marketing policy of the General Cable Corporation with respect to the products of its component divisions, and containing specification tables of this company's insulated wires and cables.—General Cable Corporation, 420 Lexington Ave., New York, N. Y.

(204) FLEXIBLE COUPLINGS—Bulletin 102, 16 pages, illustrations and descriptions of flexible couplings, tables, price list and general dimensions.—American Flexible Coupling Company, Erie, Pa.

(205) WELDING FITTINGS—Bulletin No. WT17, "Bonney Weldolets and Thredolets," working data, tables of sizes, and illustrations of typical installations.—Bonney Forge and Tool Works, Forged Fittings Division, Allentown, Pa.

(206) ARC WELDING—Catalog, 80 pages, practical manual of electric arc welding.—The Hobart Brothers Company, Troy, Ohio.

(207) ALLOY RESISTORS—Folder 940-A, "Type H Nickel Alloy Resistors."—The Electric Controller & Manufacturing Company, Cleveland, Ohio.

(208) WELDING RODS—Catalog, 20 pages, data on the line of "Regorods" for gas welding and other "Rego" equipment.—The Bastian-Blessing Company, 240 E. Ontario St., Chicago, Ill.

(209) BALL-BEARING LUBRICATION — Booklet, 11 pages, the lubrication requirements of ball bearings.—The New Departure Manufacturing Company, New Bristol, Conn.

(210) HEATERS—Bulletin No. 5, capacities of "Convectofin" heaters, tables giving equivalents in square feet of direct steam radiation which make it possible to convert figures for exposed radiators into built-in terms.—Commodore Heaters Corporation, 11 W. 42nd St., New York, N. Y.

(211) "INDUSTRIAL NEWS"—Newspaper published by the Square D Company, Industrial Controller Division, and available without charge to industrial plants, contractors, dealers, jobbers, distributors, and machinery manufacturers in the United States and Canada.—Square D Company, Industrial Controller Division, Milwaukee, Wis.

(212) STEEL FLOORING—Folder, "Inland 4-Way Floor Plate," illustrations of large and small patterns, tables of plate sizes and weights available.—Inland Steel Company, 38 S. Dearborn St., Chicago, Ill.

(213) DUST COLLECTORS—Catalog No. 1391, 15 pages, "Positive Dust Collection at Low Cost." Construction features of standard pressure and suction type dust collectors, also supplementary equipment.—Blaw-Knox Company, Pittsburgh, Pa.

(214) ARC WELDING—Booklet, 22 pages, pictures and data on a wide variety of the applications of arc welded steel construction in the manufacture of parts for machinery and equipment.—Lukenweld, Inc., Division of Lukens Steel Company, Coatesville, Pa.

(215) ROLLED AND FORMED SECTIONS—Catalog N-20, 72 pages, available standard sections listed in accordance with their applications; diagrams; weight and dimension tables; facilities of the company for pressing, stamping, forming, welding and electro-galvanizing.—Truscon Steel Company, Youngstown, Ohio.

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